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TELEPHONE ENGINEER

Volume XVII CO Y, 19

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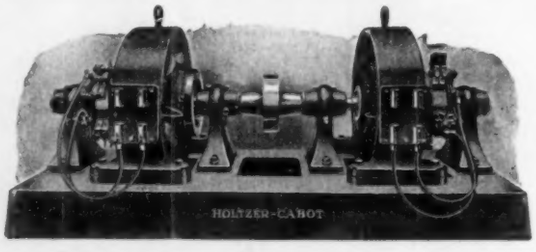

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VOL. XVII CHICAGO, MAY, 1917 No. 5

Service for the Nation

THE Bell companies are taking a great deal of perfectly justifiable pride in the splendid system of government co-operation they have built up for the needs of the war. They are investing private ownership of public utilities with all the proof it ever requires of efficiency in national service.

The prominence of the Bell system gives its present activities a great amount of unsolicited publicity. Its military preparations make unquestionably good "copy," from the newspaper man's standpoint, and the ease with which the story may be obtained completes its desirability.

Because Independent "copy" is never so available, and newspaper men have not acquired the habit of going after it, the people may be unaware that Independent telephone men are offering equally patriotic co-operation to the government. It is desirable that they should know; not from the sordid viewpoint of publicity, but that the nation as a whole may be cognizant of its powers, of the highly efficient organizations which are freely giving their facilities for its advantage.

The Independent telephone interests of the United States vest their unity in the association they support, and the association makes its connection with government activities through its vice president, F. B. MacKinnon, stationed at the national capitol. Mr. MacKinnon, therefore, has been, and is, the central figure in the co-operative arrangements with the national government. His flying trips from Washington to Philadelphia, Indianapolis, Chicago, Minneapolis, Omaha, Kansas City, Dallas and other centers of Independent activity, during which he addressed hundreds of association and company executives, was but an incidental part of the work he has been doing to put Independent telephony in the front rank of patriotism. Mr. MacKinnon is a member (with Mr. Vail and Mr. Kingsbury of the A. T. & T. Co., Mr. Carlton of the Western Union and Mr. Bruch of the Postal) of the Committee on Communication of the National Defense Board.

All Independent operators now know that the government, as a part of its military proposition, is desirous of having the fullest possible co-operation of the wire interests, such as the telephone and telegraph, inasmuch as efficient means of communication are of vital importance in all military preparations and operations.

Telephone and telegraph employes have had excellent training in the course of their daily work for usefulness in the work of the signal corps. It is desirable that such men volunteer for that sort of service to the extent that they may be available without interfering with or crippling the continuous operation of all existing communication lines in the country. These existing lines must be maintained in the most efficient manner in order to further the business of the government during the war.

All of the meetings of operators before which Mr. MacKinnon appeared passed resolutions differing from each other only in construction. They were, of course, unanimous in pledging to the President and the nation their whole-hearted support and co-operation, with the assurance that official business should have preference over private business; and they further

undertook to prepare lists of men available for direct service. The number and similarity of these sets of resolutions is our reason for not publishing them verbatim.

The co-operative patriotism of the Independent companies is as great as that of the Bell organization. They will welcome the same sacrifices and the same hardships. And as an important part of the wonderful telephone development of America they will help provide the United States Government with the most extensive and complete system of instant communication enjoyed by any nation. They will share in the glory of democracy's ultimate victory.

Independent Investments

IN ITS issue dated April 16, the "Tribune Investors' Guide" replies to an inquirer labeled "C. M. H." in this fashion:

> As a general rule the stock of an Independent telephone company, operating in a city where there is a Bell system, could not be considered a conservative investment.

The circulation of TELEPHONE ENGINEER does not parallel that of the "Tribune," and our subscribers already know the fallacy of the principle uttered. Obviously, it would be just as truthful to say that "the stock of a Bell company, operating in a city where there is an Independent system, could not be considered a conservative investment."

As a matter of fact and record, neither of those statements has any justification. Familiar as our readers are with conditions, it is not necessary that we list the many examples of secure Independent investment which exist both with and without competition. Neither is it necessary to explain, to our particular audience, the causes and conditions that make many Independent securities the best of all investments—paying exceptionally good returns upon a capital secured by an exceptional "factor of safety," as an engineer would express it.

The principles of investment in public utility securities are so well defined, and so easily investigated, that we must perforce form a poor opinion of an "investment expert" who so casually dismisses them. The really important financial advisors, who are actual students of investment principles, never fall into that error. The desirability of a telephone investment rests upon its record and the security behind its securities. That is fundamental.

It would be foolish to bring a charge of intentional bias or conscious prejudice against the "Tribune Investors' Guide." Its editor is doubtless familiar at least with the annual reports of the A. T. & T. Co. and the Chicago Telephone Company, and knows little about Independent operators outside of the Chicago Tunnel. As an "expert" of course he ought to know more; but possibly it is not entirely his fault that he does not.

The incident merely illustrates, as many other incidents illustrate, the Independent lack and need of publicity.

Some day, we hope and trust, the Independent association will be authorized by its members to employ a competent publicity man, whose sole duty will be to supply acceptable copy to newspapers about Independent progress, Independent stability and Independent investment security.

But that day should be soon, for it will take several years of earnest work to balance the long period of indifference and inertia in the matter of public information that has beset the Independent cause.

Independent investments are good. But the investment the Independents themselves should make, that would return thousands per cent in benefits, has not been made—a competent publicity department.

Equipment Used by the War Department

EQUIPMENT for the United States Signal Corps and other war departments requiring special telephone apparatus is purchased by the government in the usual manner, by calling for competitive bids from manufacturers equipped to do such work. Several, if not all, of the Independent manufacturers are busily engaged on such government orders at the present time, and need no information as to the proper procedure. If there be any who wish to have a part in this work and are not familiar with the requirements, the Washington office of

the Independent association is prepared to direct them. Orders for such equipment come from the chief signal officer at Washington, though requisitions are made by division officers.

The War Department, however, will be in need of a vast amount of ordinary telephone service at its concentration camps—the same kind of service that the operating companies habitually render to their subscribers. There is nothing special about the equipment required for this service—it consists merely of branch exchange switchboards and subscribers' desk sets.

It is not the intention of the army organization to purchase the equipment for this service, nor to operate it. Each camp will simply arrange to subscribe for the service it needs from the nearest competent operating company—presumably at established rates. Presumably, also, provision will be made to recompense the operating companies for the extra equipment required, which will pass into disuse with the cessation of war.

The rental of telephone equipment by the army instead of its purchase does not alter the fact that it is new equipment, and must be manufactured. It merely means that the manufacturer will get his orders from his old customers, the operating companies, instead of from the government. There will be no government specifications to meet, and no red tape. The camp will ask for service that demands additional equipment, and the operating company will order the additional equipment from the manufacturer. The manufacturers are already advised of this condition. Possibly some of the operators are not.

From patriotic as well as business motives, the Independent operating companies will want to give their share of service to the army concentration camps. They will be given that opportunity. It will be well for them to gather all the information they can about the probable requirements of such service and the facilities of the Independent manufacturers for executing their orders for equipment.

Those who are indifferent or dilatory in this matter will find, of course, that their competitors have installed the service and gained credit for superior readiness to meet the demands of patriotism.

The Disposal of Minor Rate Changes

THE governor of Kansas vetoed a bill passed by both houses of the state legislature providing for a change in the plan of filing rate changes with the state commission. The proposed provision was that when any new rate, rule or change in rate was filed with the commission, it would become effective in thirty days thereafter unless suspended by the commission on its own or the public's objection. Such suspension would allow the commission ten months for hearing and decision, after which the proposed change would become effective if no decision had been rendered, and remain in effect until finally passed upon.

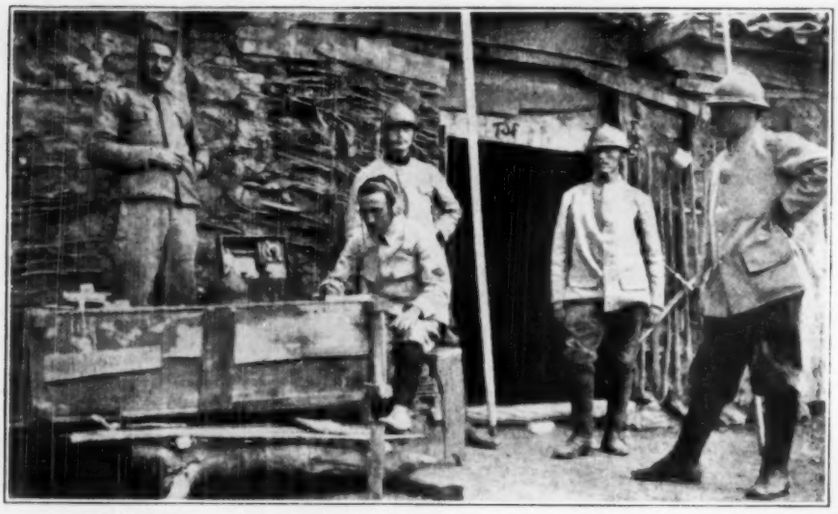
This arrangement is already in force in several states—notably Missouri—and operates to the entire satisfaction of all concerned. The governor's veto was based upon the grounds that the Interstate Commerce Commission is asking for changes in a similar plan which it now employs.

The fact is that the Interstate Commerce Commission has asked for no change in the plan, but merely for an extension of the time limits allowed for hearing—from thirty to sixty days for the first report, and to one year for the decision. It will be admitted that the federal commission needs a longer period than the state commissions, because of the complexity of the tariff changes which constantly come before it.

The advantage of the rate-filing system described in that expensive hearings on trivial changes are rendered unnecessary, with consequent relief to the commission docket and to the small telephone companies. It obviously does not change the status of protested proposals, and by clearing away those without protest makes certain the consideration of the commission within the allotted time.

The bill was a true measure of economy, benefiting the public, the companies and the commission itself. Undoubtedly the Interstate Commerce Commission so regards its own application of the system, and we are sure a more careful study of its methods and a better understanding of the minor changes it is asking would have saved the bill for Kansas. We hope there is some way to reinstate it.

Described as "once a German dug-out; now ours." A recently published "authoritative" description of German trench-shelters on the Western Front said: "All these staircases, passages, and rooms are, in the best specimens, completely lined with wood. . . . Many of the captured dug-outs were lighted by electricity. In the officers' quarters there have been found full-length mirrors, comfortable bedsteads, cushioned arm-chairs, and some pictures." The telephone is unusually prominent.—[Official Photographs.]—"Illustrated War News."



In the illustration a party of French Army wireless-operators are seen at a temporary station in a Macedonian village near the fighting-zone on the Balkan front. They are in the act of receiving reports from an aeroplane while engaged in dropping bombs on the enemy's lines. The wire leading to the station-aerial and its pole-framework may be noted overhead.—[Photos. by Press Bureau Official and C. N.]—"Illustrated War News."

The Russian "push" in Southern Silesia, undertaken to assist the Roumanians by creating a diversion which would affect the German general offensive on the Danube, steadily proceeded regardless of the hard weather in that war-area. In the illustration, battery field-telephonists are seen sending and taking in messages during an action.—"Illustrated War News."

People at home give little thought, as a rule, to the domestic side of war, being more interested in "news of battle," but to the man on active service his domestic arrangements are a matter of great if not prime importance. He studies the art of living as well as the art of killing, and the former perhaps occupies at least as much of his time as the latter, especially during the winter months when big battles are not going on and things are, comparatively, quiet. Luxury is not the prevailing note of life in British billets and dug-outs on the Western Front, whatever may be the case with the Germans.

This shows a typical British dug-out, with an officer using the telephone.—Copyright, 1917, "London Illustrated News."

M. Georges Scott, the famous French war-artist, has given in interesting sketches a reminiscence of a visit he paid recently to a French brigade headquarters near Verdun. "We were interrupted every moment by telephone calls."—Copyright, 1917, "London Illustrated News."

A remarkable feature of the fighting during the British advance on the Western Front is the artillery work. "Liaison" officers do the work with field telephones. As the infantry battalions advance, they push on after them, with signallers carrying reels of telephone wire, and report the progress of the attack to the battery-commanders, enabling these to keep continually shifting forward the barrage fire. An officer is seen beginning work on clambering out of a trench—the figure running forward through a gap in the wire entanglement, stick in hand. In his right hand the officer carries the telephone-box. As he stops to report, the men, seen following with a reserve telephone and reels of wire (one of which is kept "paying out" as the bearer moves) instantly attach the wire to the telephone, and a message goes off.—Copyright, 1917, "London Illustrated News."

For temporary purposes, where an hour or two's stay may be expected, or for use in cold winds or wet weather, French ingenuity has devised the efficient portable shelter for telephone-operators in the field, at work in the open, seen here. The apparatus, in shape not unlike the tente d'abri of the French Army, is collapsible, and, with the struts closed and the cross-battens disconnected, can be folded and easily carried. The lower transverse battens, as seen, offer a seat for the operator, who can keep his message-block or note-book hung up beside him while at work, comfortably settled inside.—[Photo. by C. N.]—"Illustrated War News."

Many tributes have been paid to the efficiency of the British Army's telephone service on the Western Front, and our photograph indicates that at Saloniki also the telephone plays an important and useful part in the operations. Lord Northcliffe, after visiting the front in France, described the army telephonic system as unique. "Every officer," he writes, "or head of department of importance in the British zone, has a telephone at his hand. You go into a stable, and see a switchboard which connects every Command along the line, in addition to those which go to London or Paris." [Official Photograph.]

STORIES IN PICTURES OF TELEPHONE PRACTICE AND PROGRESS IN ALL PARTS OF THE WORLD.

Independents Confer on Preparation

For the purpose of helping to recruit 5,000 experts needed in the reserve of the United States signal corps and of planning to make the service of the great telephone systems most useful to the government in time of war, a series of conferences of Independent telephone officials is being held throughout the country. A meeting of officials from Indiana, Ohio, Illinois, Michigan and Kentucky was held in Indianapolis April 16 at the Claypool hotel. The meeting was called by F. B. MacKinnon, of Washington, vice-president of the United States Independent Telephone Association, who is a member of the committee on communication of the council for national defense. Among those who took part were:

Mr. MacKinnon, H. F. Farwell of Terre Haute, president, and Frank Bohn of Ft. Wayne, secretary of the Indiana Independent Telephone Association; William Fortune of Indianapolis, president of the Indianapolis Telephone Company; Frank L. Beam of Mt. Vernon, Ohio, and H. P. Folsom of Circleville, Ohio, secretary of the Ohio Independent Telephone Association; Samuel Heller and P. S. Pouge of Louisville, Ky., representing the Independent companies of Kentucky; E. Glandon of Pittsfield, Ill., president, and B. F. Baker of LeRoy, Ill., secretary of the Illinois association; C. E. Tarte and Frank V. Newman of Grand Rapids, Mich., president and secretary, respectively, of the Michigan association; H. L. Reber of St. Louis, representing the Kinloch Independent lines, which operate in Illinois, and all the directors of the Indiana association.

"The efficient working of the army and navy, both as fighting forces and during the time of preparation and training," said Mr. MacKinnon in opening the meeting, "depends largely upon the efficient working of the lines of communication between Washington, the various army and department headquarters, the army posts, supply depots and munition factories. The existing telephone and telegraph lines are relied upon to furnish these valuable lines of communication. In order that these lines be constantly ready for service and that service rendered in accord with government regulation, it is necessary that there be a very close co-operation between the various companies operating the systems of communication."

Mr. MacKinnon said the committee on communication of the council for national defense consists of five men representing the Western Union, the Postal Telegraph and the Bell and Independent telephone systems. He added that the Independent groups he represented consisted of 8,000 telephone companies operating 5,000,000 telephones, all classed as public service companies, which in time of war "are the servants of the public indeed." The federal government has need of the systems, it was explained, and the state authorities must use the lines and instruments. He said the companies should co-operate closely with the national and state governments.

"The signal service corps," said Mr. MacKinnon, "is made up of officers and men experienced in handling telephone equipment—in constructing and building telephone lines. This corps needs 5,000 men in its reserve. The telephone companies must furnish these men. I am here to urge you to plan a systematic campaign for recruiting the battalions needed. The Independent companies have long ago demonstrated their ability and desire to serve. I am sure they will take advantage of these new opportunities."

Similar meetings have been held in Chicago, Minneapolis, Omaha and Kansas City.

Michigan Senate Defeats City Bill

The Michigan state senate has defeated the Ormsbee constitutional amendment, which would allow cities to own and operate telephone systems. The measure received 19 votes to 11 against it. Thus it lacked three of the necessary two-thirds.

A reconsideration of the bill was obtained so that it might be tabled. Attorney-General Groesbeck explained the measure to its opponents, and it will doubtless be brought up for a vote again in the near future. It had already passed the house.

Senators Bolen, Bryant, Forrester, Holmes, McRae, Morford, Planck, Scott, W. W. Smith, Stewart and Tufts voted against the bill. Condon, Covert, Damon, DeLand, Foster, Hanley, Harrington, Koehler, Martin, Murtha, Penney, Roberts, Scully, Tripp, White, Wilcox, Willison and Wood voted for it.

Prior to the vote on the bill Senator Damon tacked on an amendment allowing citizens to appeal to the railroad commission where the rates charged by a municipal company are excessive. Senator Forrester also put in an amendment which would bar cities under 25,000 from coming under the provision.

Wire Earnings Grow

The American Telephone & Telegraph Company reports for the quarter ended March 31 last a gain in net profits available for dividends of about $500,000, compared with the same period in 1916. The totals are $19,012,201, against $9,495,233. There is added to the surplus after paying dividends $2,097,564.

The report of the Bell Telephone system in the United States accompanying that of the American company shows an increase of $523,408 for the month of February and of $1,123,998 for two months ending February 28.

The income statement of the American Telephone & Telegraph Company for the first quarter follows:

	1917.	1916.
Earnings	$14,192,386	$12,592,109
Expenses	1,650,423	1,338,871
Net earnings	12,541,966	11,253,238
Interest	2,529,765	1,758,005
Balance for dividends	10,012,201	9,495,233
Dividends	7,914,636	7,653,970
Surplus	2,097,564	1,841,262

War May Stop Massachusetts Inquiry

The proposed investigation of the Bell Telephone Company by the public service commission may be postponed because of the unusual conditions arising from the war. The entire question was considered April 11 by a conference committee of the Senate and the House. Philip L. Spaulding and M. B. Jones, respectively president and counsel of the telephone company, were present at the request of the committee and told of the unusual work which the company is doing for the Federal Government in preparation for war.

The telephone officials, however, did not ask that the proposed investigation be postponed; they merely suggested that the company is working under unusual conditions and that an examination of its affairs might not disclose the usual state of affairs.

Messrs. MacLeod and Eastman of the public service commission agreed that conditions are unusual, but urged that their commission receive the funds for the investigation. They assured the committee that the commission would in no way embarrass the company in the extraordinary work it is doing.

Telephone Transmission

Notes Prepared by the Department of Electrical Engineering, Iowa State College, Ames, Iowa

BY CHARLES ALLEN WRIGHT

THIS article is written to point out without the use of mathematics some of the interesting aspects of telephone transmission.

The electric current in a telephone circuit during conversation is alternationg at frequencies between 50 and 5,000 cycles per second. Figure 1 shows a sine wave alternating current and Figure 2 shows the character of the current in a telephone circuit (part of vowel sound "E.")

Electromotive force forcing current through an electric circuit has to overcome the effects of resistance, leakage, capacity, and inductance.

The effects of resistance in an electric circuit are well known. Leakage is the escape of current through or over the insulation.

A condenser forming capacity in a circuit permits current to flow through it. If a constant e. m. f. is applied at its terminals, current flows for a short time and then stops. If the e. m. f. is alternating, current

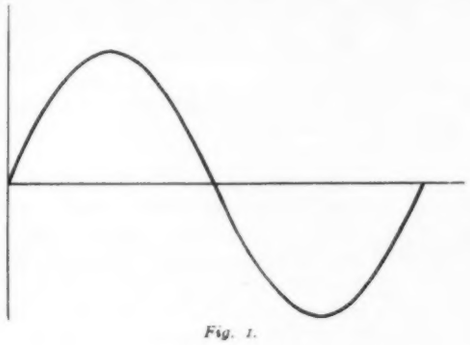


Fig. 1.

flows first in one direction and then in the other, the condenser alternately charging and discharging.

The higher the frequency, the greater is the current that flows.

The capacity is increased by increasing the area of the plates, by increasing the dielectric constant of the dielectric, or by decreasing the distance between the plates.

Figure 3 shows a circuit in which there is a condenser, and Figure 4 shows the section of a cable. It is to be noted that any two conductors of a cable with the insulation between them form a condenser, and that the capacity between these wires is increased as their size is increased, as they are placed closer together, or as the dielectric constant of the insulation is increased by the use of an impregnating compound.

When current flows through a conductor lines of force are set up around that conductor and when the current changes, the building up or the collapsing of these lines of force induce an e. m. f. in the conductor in such a direction as to tend to prevent the change in the current. The effect of this induced e. m. f. in a conductor is referred to as "inductance." The combination of resistance and inductance effects is known as "impedance." Impedance retards the flow of alternating current just as resistance does, but the energy used up in the circuit is only that used up in overcoming resistance. The inductance of a circuit gives back all the energy it absorbs. Figure 5 shows the inductive effect of current in a circuit. Note that the inductive effects of two adjacent wires neutralize each other.

In Tables 1 and 2 are given the constants of several types of commonly used telephone lines, which have

Fig. 2.

been taken from the Standard Hand Book for Electrical Engineers, 4th edition.

TABLE 1.

Constants Per Loop Mile.

Kinds of Non-Loaded Open Wire Lines.	*Effective Resistance (Ohms).*	*Effective Inductance (Henries)*	*Effective Capacity (m.f.)*	*Transmission Equivalent.*	*Miles Equivalent to 30 Miles of Cable. Standard*
No. 8 B. W. G. Bare Copper, pairs	4.08	.00337	.00898	.035	860
No. 8 B. W. G. Bare Copper, phantoms	2.04	.....	.....	.029	1,035
No. 8 B. W. G. Bare Iron, (BB) pairs	...	.....	.....	.22	135
No. 12 B. W. G. Bare Iron, (BB), pairs	.85	.0150	.....	.32	93

TABLE 2.

Constants Per Loop Mile.

Kinds of Non-Loaded Cable Circuits.	*Resistance (Ohms).*	*Capacity (m.f.).*	*Insulation (Megohms).*	*Transmission Equivalent. Miles Standard Cable.*	*Equivalent to 30 Miles of Standard Cable.*
No. 19 A. W. G. Dry Core Paper Cable, pairs	88	.060	500	1.00	30
No. 22 A. W. G. Dry Core Paper Cable, pairs	176	.083	500	1.66	18
No. 19 A. W. G. Dry Core Paper Cable, pairs	88	.074	500	1.11	27
No. 22 A. W. G. Sw. Bd. Cable (sandc.), pairs	176	...	100	2.2	14
No. 16 A. W. G. Sw. Bd. Cable (wool), pairs	44	...	100	1.1	27

As the wires of an open wire line are widely separated the distributed capacity is small and the inductance is comparatively high. Therefore such a line may be

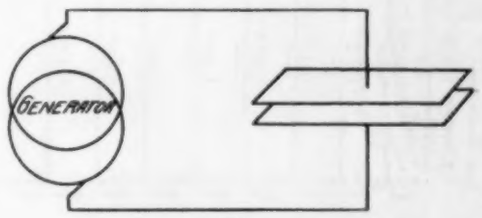


Fig. 3.

represented by a number of resistances and impedances in series. On the other hand the wires of a cable pair are close together, the inductance is negligible, and the capacity between wires is high. It may best be represented therefore by a number of resistances in series, with condensers bridged across the line. It is to be remembered that the frequency of the current in a telephone circuit

varies, and that the higher the frequency the more of it will flow through the distributed capacity of the circuit. Therefore more of the high frequency current of the high notes is shunted off from the receiving end of the circuit than the low frequency current of the low notes. The low notes are received more strongly than the high notes, and the "quality" of the tone is affected. As both low and high frequency currents are shunted the current at the receiving end is "attenuated" and the "quantity" of

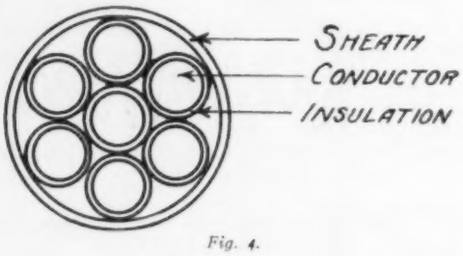


Fig. 4.

the sound is affected. Also attenuation results from the e. m. f. in the circuit being used up in overcoming the resistance of the circuit.

Where there is a discontinuity in the circuit, a piling up of the current and voltage waves occurs in such a way that losses in transmission occur. These losses are known as "reflection" losses.

Circuits are loaded by inserting impedance in series in them at intervals so short that appreciable reflection losses are avoided. These impedances decrease the energy loss in the circuit by their tendency to neutralize the bad effects of the capacity. They make it possible to apply a higher voltage to the line without increasing the current proportionally. In this way they decrease the attenuation. By changing the relation between the resistance, leakage, capacity, and inductance of the circuit, they decrease the distortion. Thus they better the received sound both in quantity and quality.

In addition to the above high-frequency losses there occur what are known as battery-supply losses. The greater the direct current supplied to the transmitter, the greater will be the energy which that transmitter sends out into the circuit, but the amount of this current is limited by the heat radiating qualities of the transmitter. The transmitter is therefore used most efficiently when the amount of direct current supplied to it normally is the greatest possible without unduly heating the carbon path in the transmitter. A loss due to a decrease in the direct current normally supplied to the transmitter is known as a "battery-supply" loss.

The quantity of sound transmitted over a telephone line under various conditions might be indicated by delicate apparatus, but this would not take account of the distortion of current or quality of the sound received. What it is necessary to measure is "transmission" or a combination of quantity and quality of received sound, and in order to do this a unit of transmission must be chosen and a standard of transmission devised.

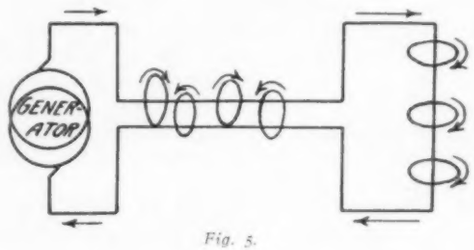


Fig. 5.

A unit is an arbitrary division for measurement. A standard is the means of making the measurement; for example, a foot and a foot rule, or an ampere and an ammeter.

A primary standard is one from which secondary standards are calibrated. It should be first, Constant for specified conditions, and second, Reproducible from written instructions—but not necessarily cheap or portable. A secondary standard must be, first, Cheap, second, Portable, and third, Constant for specified conditions.

It was necessary to choose a unit and standard of transmission because "transmission" had never been measured before. The unit chosen was a "mile of transmission" over "the standard circuit." The primary standard chosen was the No. 19 gauge non-loaded cable then in use, having a mutual capacity of .06 micro-farads per mile and a loop resistance of 88 ohms per mile, with the common battery central office and substation circuits then in use. Artificial lines made up of resistances and condensers mounted in a box with the same central office and substation circuits at both ends have been used as secondary standards.

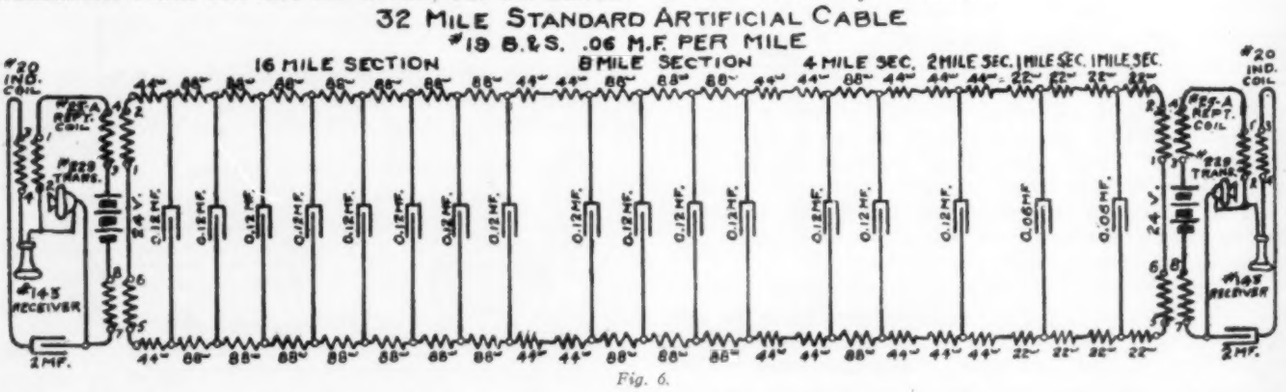


Fig. 6.

The standard circuit is shown in Figure 6. The designations shown refer to apparatus manufactured by the Western Electric Company. Figure 7 shows a commonly used artificial cable with the associated apparatus.

In testing transmission it is necessary to find the number of miles of No. 19 gauge standard cable which in the standard circuit will give the same transmission

when talking over the standard circuit, as when talking over the circuit under test. The transmission over a circuit may be different when talking in one direction than when talking in the other.

When testing transmission the tester who is talking should be careful not to vary his voice or the distance of his mouth from the transmitter mouthpiece. He should do all necessary switching, keeping the

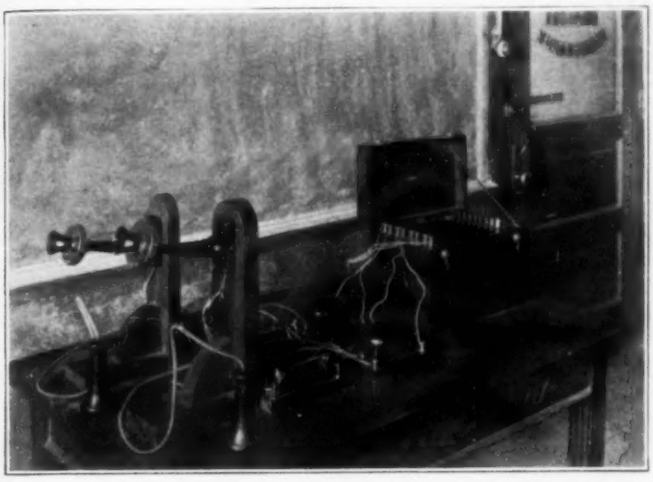


Fig. 7.—Photograph of Artificial Cable and Associated Apparatus.

tester who is receiving always in ignorance of the condition of the circuit. This is necessary in order to avoid any error due to the personal equation or opinion of the receiving tester.

If it is desired to test a transmitter or other unit of the terminal apparatus, such as the induction coil or battery, the artificial cable with standard terminal apparatus at one end is arranged so that it may be switched to standard terminal apparatus, or terminal apparatus all units of which are standard except the transmitter or other unit under test at the other end. It is then determined by careful trial what length of artificial cable with the terminal apparatus under test will give the same transmission as the standard terminal apparatus with 20 miles of artificial cable. If this length of cable should be 16 miles, the transmitter under test is said to be 4 miles poorer in transmission efficiency than the standard. If it should be 24 miles, the transmitter is said to be 4 miles better than the standard.

In Figure 8 is shown the circuit used in comparing a transmitter with a standard transmitter. A similar circuit may be used for testing induction coils or other elements of the substation set. Figure 9 shows a circuit for comparing two substation sets.

If two artificial cables are available, a balancing cable is used as shown in Figure 10. This avoids the operation of one or more switching keys each time the standard or test apparatus is cut into circuit.

The effect on transmission of holding the mouth at varying distances from the mouthpiece of the transmitter may be determined in approximately the same way. However, only the standard terminal apparatus need be used in this case.

The following losses in miles of standard cable for two types of transmitters, determined by a prominent telephone engineer, result from talking with the mouth at the given distances from the mouthpiece of the transmitter:

Distance of mouth from mouthpiece of transmitter, in inches.	*Loss in miles of standard cable. Microphonic type of transmitter.*
.5	3.5
1.0	5.5
1.5	8.0
2.0	11.0

If it is desired to test the transmission efficiency of a length of cable or a line, and if only one circuit is available, it is necessary to connect one of the substation circuits at the distant end of the line, and arrange with the wire chief or someone else at that point to aid in the test. The transmission over the above substation circuits with 35 miles of No. 19 gauge cable is generally regarded as the limit of commercial transmission. It is possible to determine this amount of transmission from memory more definitely than any other amount. Artificial cable is added to the circuit under test until 35-mile transmission is obtained. Then the number of miles of artificial cable thus necessary, substracted from 35, will give the transmission equivalent of the circuit under test. Figure 11 shows the circuit used in making this test.

If two circuits to a distant point are available which follow the same course and which are so nearly the same that their transmission equivalents may be assumed to be equal, the simplest way to test them is to loop them as in Figure 12, find the transmission equivalent of the two circuits in series, and divide the result by 2 to obtain transmission equivalent of either circuit.

If the circuits to be tested follow different courses, and it is probable that their transmission equivalents are

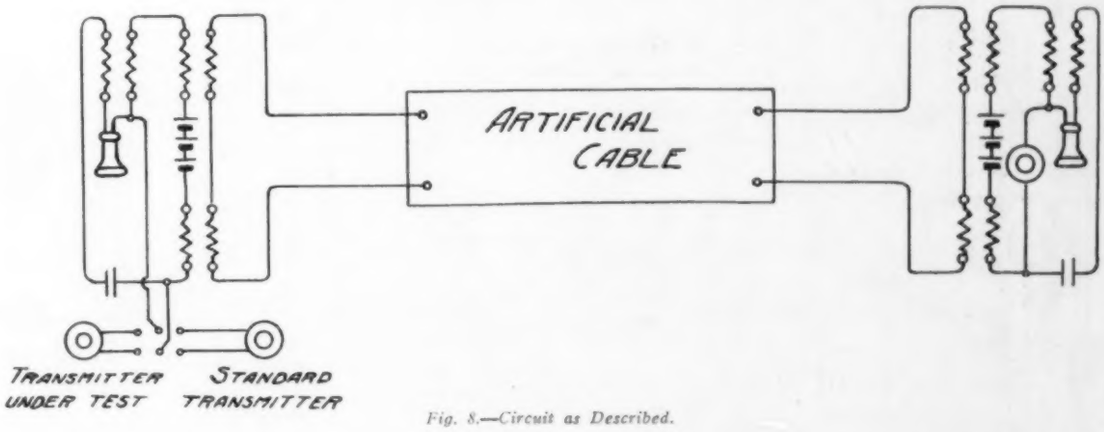


Fig. 8.—Circuit as Described.

different, they should first be looped together as in Figure 12, and their series transmission equivalent found. Then one of the substation sets should be transferred to the other end as in Figure 13 and it should be carefully determined what amount of artificial cable it is necessary to insert in the circuit the transmission of which is the better in order to make the transmission over the two circuits the same. This amount of artificial cable is the difference in the transmission equivalents of the two circuits. If a and b represent the equivalents obtained in these two tests, and if x and y represent the transmission equivalents of the two circuits then from the relations $x + y = a$, and $x - y = b$, the transmission equivalents desired may be easily obtained. It will be found that $x = \frac{a+b}{2}$, and $y = \frac{a-b}{2}$

If x, y, and z represent the transmission equivalents of three circuits, none of which follow the same course, the tests may be made with all the substation apparatus and the artificial cable at one end of the circuit. The aid of a wire chief or a maintenance man in changing connections is all the aid that is necessary at the distant end of the circuit. If we find from using the method of testing described for Figure 12 that $x + y = a$, $y + z = b$, and $z + x = c$, the transmission equivalents of x, y, and

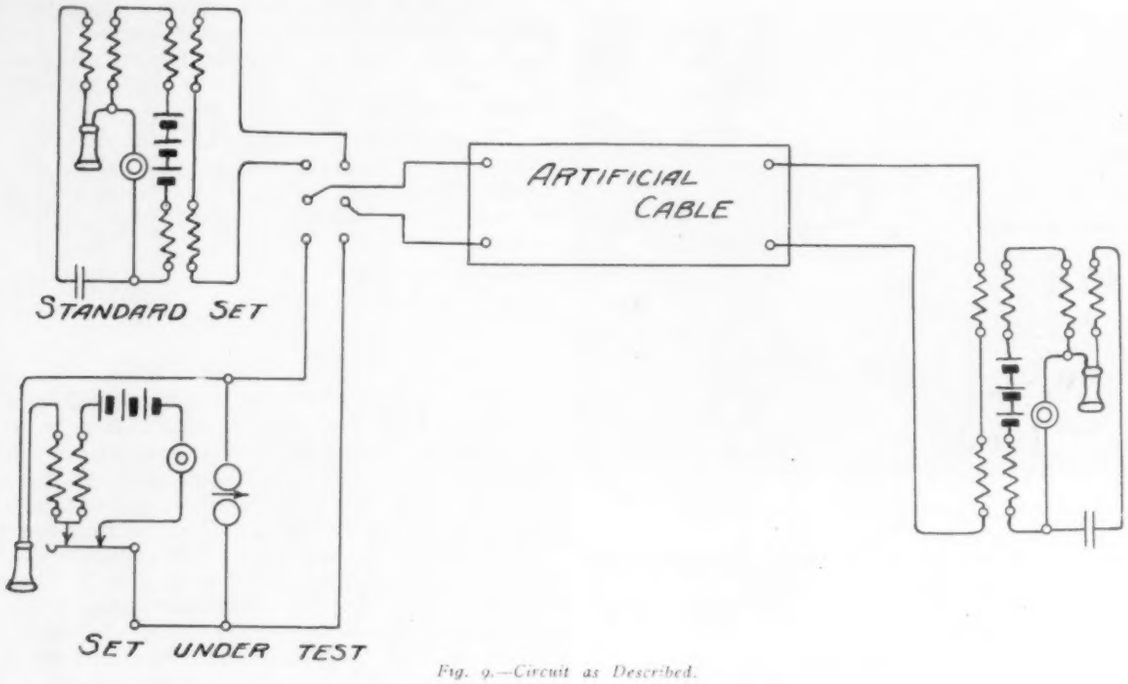


Fig. 9.—Circuit as Described.

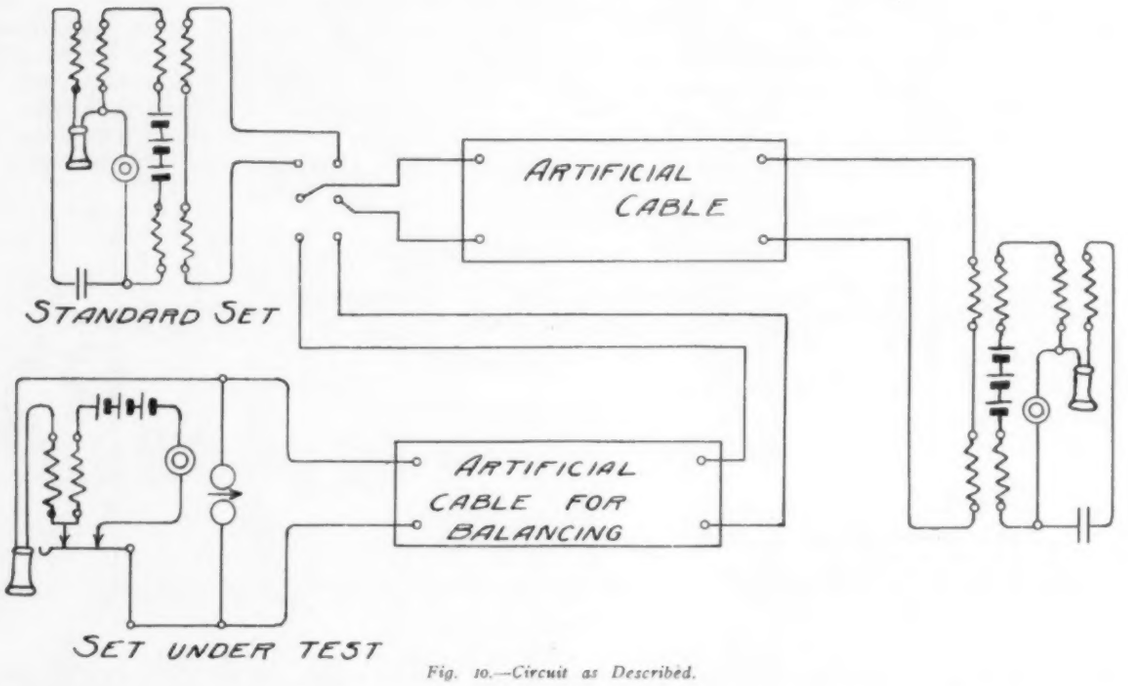


Fig. 10.—Circuit as Described.

z may be determined. It will be found that $x = \frac{a+c-b}{2}$, $y = \frac{a+b-c}{2}$, and $z = \frac{b+c-a}{2}$

A transmission equivalent of a piece of apparatus or a section of a circuit is the loss in miles of transmission which that apparatus or section of circuit will cause when inserted in a telephone connection. Values of transmission equivalents for various types of telephone lines and apparatus have been determined by the various manufacturers and users of telephone equipment.

The transmission equivalents of various types of circuits are given in Tables 1 and 2. In Table 3 are given approximate transmission equivalents of various typical pieces of apparatus. (Published in an article in TELEPHONE ENGINEER, in August, 1915, by C. J. Larsen).

TABLE 3.

Apparatus.	*Approximate Transmission Equivalent.*
Average wire wound heat coils	0.500
Tinsel cords, per pair	0.030
Steel cords, per pair	0.250
1,000-ohm bridged drop	0.150
500-ohm bridged drop	0.975
200-ohm bridged drop	2.000
2 m. f. condenser	0.160
Early type repeating coil	5.000
Subsequent, improved repeating coils	2.000
Present-day repeating coil	0.500

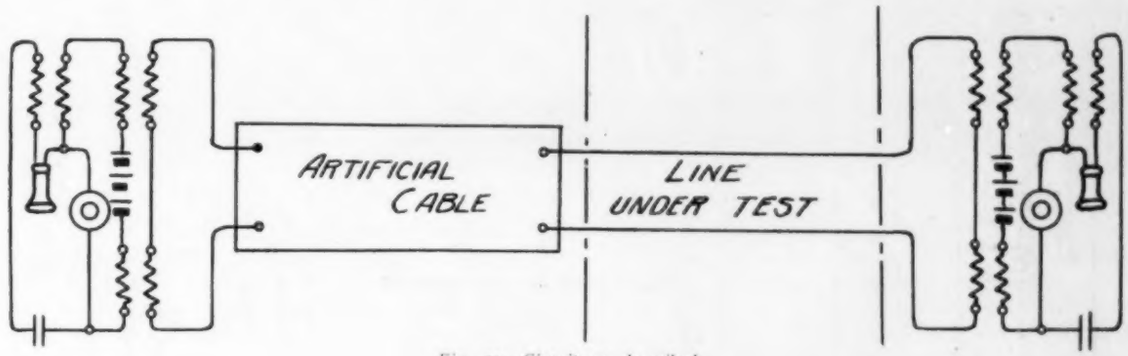


Fig. 11.—Circuit as described.

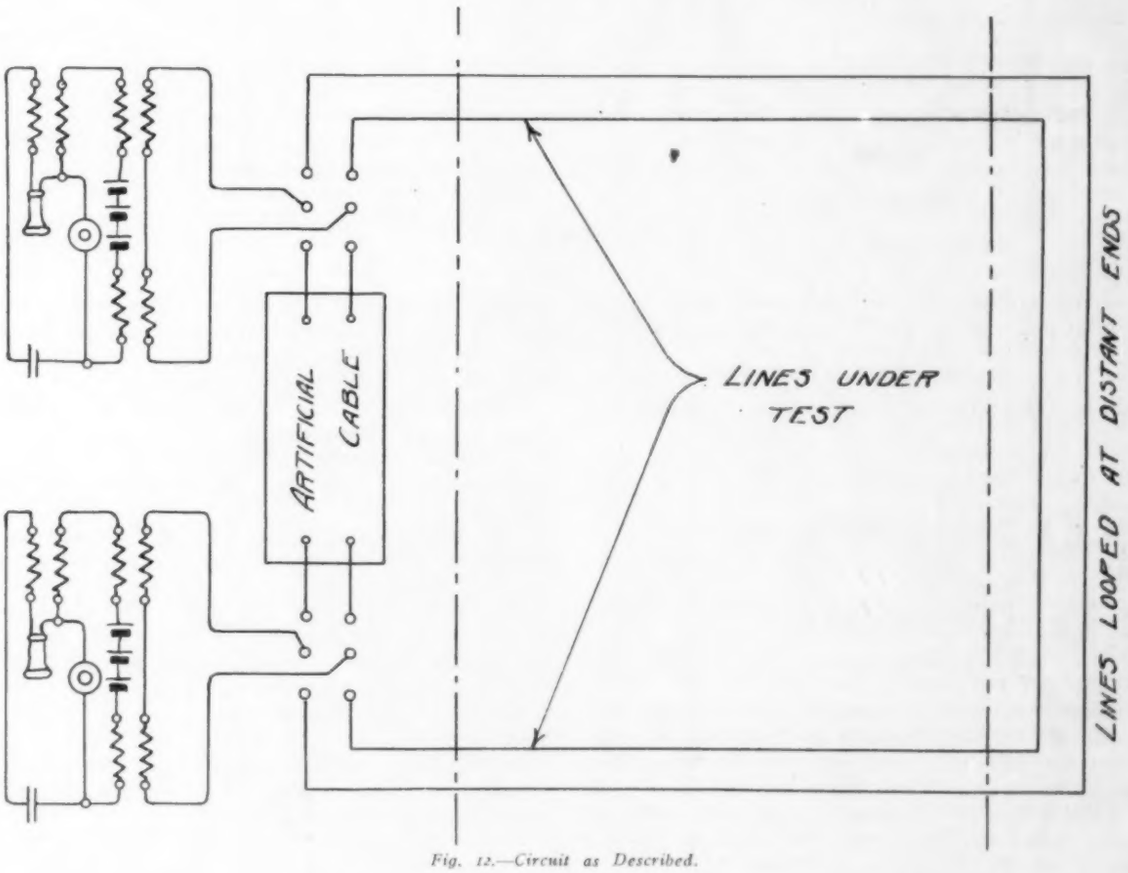


Fig. 12.—Circuit as Described.

To these transmission equivalents may be added several others taken from the Standard Handbook for Electrical Engineers, 4th edition, which are of common interest:

1,000 ohm bridging bell	Less than 0.1
Efficient phantom repeating coil	
on phantom	0.05 to 0.15
on side circuit	0.25 to 2.0
Operator's set, bridged across line	0.5 to 5.0

"Reflection losses between non-loaded open wires of different sizes or side circuits and phantoms, or open wires and cables are usually but a fraction of a mile of standard cable. In the cast of a loaded open-wire circuit connected to an open-wire non-loaded circuit, the reflection loss may become equal to 3 or 4 miles of standard cable."

The transmission equivalents (miles of standard cable which give the same transmission loss as one mile of the cable in question) of various types of cable are given in Table 4. This data is taken from "Gibson's Manual of Telephone Troubles." Because of the slightly different characteristics of the cables and wire tested this data does not exactly check with that of Tables 1 and 2.

TABLE 4.

TRANSMISSION EQUIVALENTS OF TELEPHONE CABLES AND WIRES.

	Loaded Cable			Non-Loaded Cable
	Heavy	Medium	Light	
Underground Cable, No. 22 B. and S. Gauge...	.53	.70	.95	1.61
Underground Cable, No. 19 B. and S. Gauge...	.278	.348	.455	1.0
Underground Cable, No. 16 B. and S. Gauge...	.170	.195	.248	.74
Underground Cable, No. 14 B. and S. Gauge...	.132	.14	.160	.60
Underground Cable, No. 13 B. and S. Gauge...	.113	.117	.135	.53
Open Wire, No. 12 N. B. S.....	.03	..	..	.03
Open Wire, No. 8 B. W. G.....	..	..	..	.035
Dry Core, No. 16 B. and S. Gauge.....	..	..	..	1.05
Dry Core, No. 13 B. and S. Gauge.....	..	..	..	.75
Bridle Wire, No. 14 B. and S. Gauge.....	..	..	..	.86
Swbd. Cable, No. 22 B. and S. Gauge.....	..	..	..	2.16
Swbd. Cable, No. 19 B. and S. Gauge.....	..	..	..	1.65

The insertion of such a resistance in a common battery loop that the current through the transmitter is decreased from its value in a zero loop to one-tenth of this value may cause a loss of ten miles of standard cable or more, while a loss of the same amount may result in a local battery set from decreasing the voltage across the transmitter to one-third its normal value.

Loose connections, or "high joints," and grounds may cause losses which are negligible or of such a value as to make conversasion over a telephone impossible.

As the various losses given above are additive, the occurrence of many such losses, each small in itself, may prevent the use of a telephone line.

The various values of transmission given above are approximate as they vary with the conditions in the rest of the circuit and the position of the apparatus in the circuit.

The cost of such transmission losses is determined by the cost of improving other parts of the connection, as the lines, by loading or by the installation of telephone repeaters, to bring the transmission over the whole connection up to the standard which is being maintained. It is to be remembered, however, that if at the start the transmission is better than the standard which it is economical to maintain, and the added transmission loss does not make the transmission equivalent of the circuit poorer than this standard, it is generally considered that

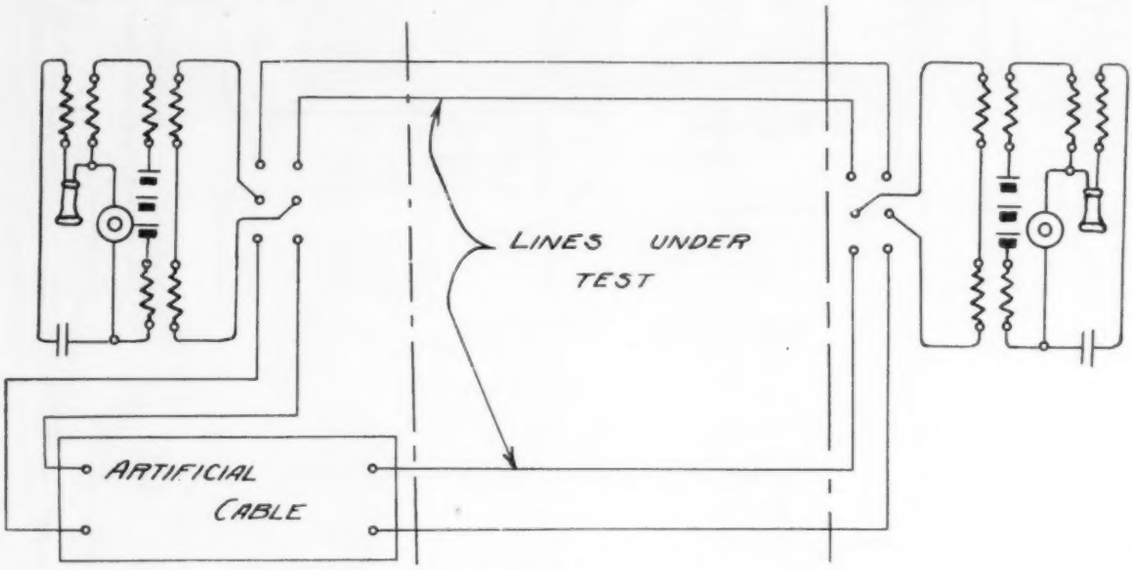


Fig. 13.—Circuit as Described.

such a transmission loss has no value, just as air, water, or sand have no value when there is a superabundance of them available. The transmission may even be so good that it is disagreeable to the subscriber.

The addition of a traffic feature to a circuit which cause a loss in transmission will "prove in" if the saving in operation plus the value of the betterment in service will balance the cost of the apparatus plus the cost of the transmission loss.

If transmission is too poor, people will not use the telephone, and income will be decreased. If transmission is too good, the cost of the circuits and lines will make the cost of service too high. Balancing the amount of service against the cost of circuits we can determine the proper quality of transmission to maintain in order to give the greatest return to the telephone company. A standard of 20 miles has been generally maintained for local service, and 30 miles for toll service. With the cheapening of telephone apparatus the standards of telephone transmission which it is economical to maintain are constantly becoming better.

In five towns in Western Pennsylvania, in an effort to better telephone transmissions, inefficient repeating coils, cords, heat coils, and other apparatus were replaced by better apparatus, old transmitters were replaced, run down batteries were renewed, and other similar changes in plant were made. The result was that in eight months the commercial transmission areas were increased between 50 and 100 per cent, and the amount of toll and long distance business in this territory increased about 25 per cent.

Indiana Managers and Operators Meet

Quarterly Meeting of Central Indiana Telephone Owners' Association at Noblesville

Managers and Operators at the Meeting of the Central Indiana Independent Telephone Owners' Association, Noblesville, Ind., April 17.

THE quarterly meeting of the Central Indiana Independent Telephone Owners' Association, held at Noblesville, April 17, was divided into two branches. One division was for the managers, and was conducted by the officers of the association, J. A. Browne, president, and M. F. Hosea, secretary-treasurer. The other division, the operators' school, was conducted by W. S. Vivian, of Chicago, secretary-treasurer, United States Independent Telephone Association, assisted by C. E. Doolittle, traffic superintendent of the Citizens' Independent Telephone Company, Terre Haute.

The welcome address at the meeting of the managers was delivered by Judge E. E. Cloe of the Hamilton circuit court. Judge Cloe said he was quite familiar with the Independent telephone movement and Independent telephone men deserve a great deal of credit for the work they have accomplished in the past 15 years, because to his knowledge they put up one of the best fights against monopoly that has ever been displayed in any business in the United States. In connection with this statement he said that E. Hawkins, manager and secretary of the Home Telephone Company, at Noblesville, began in the telephone business in Noblesville between 15 and 20 years ago.

The company was opposed by the Central Union Telephone Company, but had won commercial victory and has full control of the telephone business in Noblesville today. Judge Cloe directed attention to the fact that Noblesville was one of the first companies to install a common battery switchboard, and has today an ideal plant and is giving to the people of Noblesville excellent service.

M. F. Hosea, secretary-treasurer of the association, responded to Judge Cloe's address, thanking him for his hearty welcome to Noblesville. He expressed appreciation to the members of the association for their hearty support of President J. A. Browne, in responding so promptly to his letter asking for their support in holding the operators' school in conjunction with the meeting. Mr. Hosea also thanked the members for their hearty support and co-operation with Chairman J. A. Browne, of the legislative committee, during the last legislature, for their untiring efforts in responding to requests for telegrams and letters to be written to their respective senators and representatives. This co-operation accomplished the things that were planned by the Iidiana Iidependent Telephone Association.

President Browne explained in detail what bills were passed that the association worked for, and also those that failed to pass which would have worked to the disadvantage of the telephone interests. Mr. Browne stated that we would have undoubtedly accomplished more had it not been for the opposition that was shown by the Bell interests. There was a vote of thanks extended to Mr. Browne for his diligent work.

Lynton T. Block, president of the Utilities Indemnity Exchange, St. Louis, Mo., gave an interesting address on the different phases of insuring property of the telephone companies and also of taking care of their indemnity insurance. In his address he explained the proper methods to pursue in case of accident. The address of Mr. Block was received with great interest because all members present carried some sort of insurance, and it was of interest to them to hear the different questions discussed. He promptly answered a number of questions. His experience in the insurance business has been so general that the information given was valuable, for it is known that he is an authority along this line.

J. K. Johnston, of Indianapolis, gave an interesting paper entitled "Making Friends for a Business." He brought out many splendid facts that should be given special attention in commercial departments by all telephone companies. He laid great stress upon the employe being polite in all his dealings with the subscriber, as it will gain good will for a business that money will not buy.

Rev. C. M. Byerly, president of the Kingman Telephone Company, Kingman, Ind., prepared a paper on the "New Constitution," and in his absence it was read by C. R. Bleakney, general manager of the S. Morrison Telephone Company, Greenfield. This address was confined to the new state constitution, which will be formed at a convention to be held next year.

Claude R. Stoops, manager of the Napanee Telephone Company, who is on a committee for the Indiana Independent Telephone Association, gave details as to how the various Independent telephone companies can assist the United States and the state of Indiana, in taking care of telephone communications during the present conflict. He presented the resolutions of loyalty to the government that were passed at the meeting of Independent telephone men from the Central states, which met in Iidianapolis, April 16. A motion was made and carried that the Central Indiana Independent Telephone Owners' Association concurs in these resolutions.

H. M. Friendly, Indianapolis, was called on to explain the work that had been carried out by Mr. Torrey, who has represented the Indiana Independent Telephone Association on transmission work for a number of months. Mr. Friendly stated that a great deal of good had already been accomplished through Mr. Torrey. There have been a great many changes in cord and

switchboard circuits, and a great many repeating coils have been changed. This has greatly improved the transmission over long distance lines in Indiana.

W. S. Vivian of Chicago, who had charge of the operators' school, brought out a number of new ideas. The first was a written examination. The questions were written upon the blackboard and each operator was furnished with proper stationery to give written answers to the questions. These papers were exchanged and corrected in order to ascertain those who were not familiar with rules and regulations. On the questions that were not properly answered the correct answer was given for the operator's benefit.

This school was conducted in the county superintendent's room of the court house, which was provided with desks and large blackboards, thus adding to the efficiency of this work. It is unquestionably true that this school was one of the best conducted in Indiana for years.

Before the adjournment at noon and in the evening, the managers visited Mr. Vivian's school, devoting about half an hour each time, in order to familiarize themselves with his method of instructing the operators. It was a surprise to all the managers, when entering the schoolroom, to see the large number of real students at work. There was not one minute lost during the whole day, and all that one could hear among the managers was complimentary to Mr. Vivian as to the manner in which he handled the operators, and the interest that they took in his school. The instructions given to the operators and the opportunity afforded to become acquainted will no doubt better Indiana Independent long distance service.

Mr. Vivian was assisted by C. E. Doolittle, of Terre Haute. Large cards were ruled up to represent the long distance tickets, and used to demonstrate the proper method in making long distance tickets and the proper information that should be placed on the backs of tickets during the course of the passing of calls in getting the service established.

There were in attendance at this school 70 to 75 operators, coming from the following places: Atlanta, Hope, Middletown, Danville, Brownsburg, Pittsboro, Noblesville, Franklin, Carmel, Westfield, Jolietville, Lapel, Indianapolis, Greenfield, Knightstown, Edinburg, Columbus, Richmond, Martinsville and Cambridge City.

The next regular meeting of the association will be held in Columbus, Ind., July 17. All Independent telephone companies, and all Independent manufacturers and supply men are cordially invited to attend.

Postal Increasing Telephone Activity

Acccording to certain officials of the Postal Telegraph-Cable Company, the establishment of a powerful rival to the Bell Telephone in the telephone field is being considered in the project to extend the Postal Telegraph's telephone system into the Middle Atlantic states.

It is stated that for some time past the Postal Company has considered the extension of its telephone system, which is already in operation throughout the West and South, to the Middle and North Atlantic coast districts. In a dispatch sent out from Chicago it was stated that the company planned to enter the telephone field over the entire country on a very large scale. This dispatch stated that the present intention was to establish the new telephone system in the larger centers of population and from these to radiate gradually into the country until the entire nation was linked up with the new system.

It was explained that the wires already owned and controlled by the Postal Company and used for the transmission of telegraphic messages could very easily be transposed to serve as telephone wires also. In the cities west of Pittsburgh, in the Middle West, on the Pacific coast and throughout the South, particularly in the Carolinas, it is said the company has already inaugurated local and long distance telephone service which is being extensively patronized.

The informant added the interesting information that everywhere that the Postal service had been introduced hitherto it had successfully cut Bell Telephone rates from 15 to 50 per cent.

To Discourage Unofficial Directories

The Chicago Telephone Company hopes to thwart the activities of the overly ambitious local telephone directory promoter and in such an attempt instructions have been issued to patrons of the company not to encourage such publications, which, it is claimed, only tend to reduce efficiency in that they are published but seldom and in many cases used indefinitely. The following notification has been issued:

"Our patrons are cautioned against using telephone directories issued without authority by persons seeking to use such publications as advertising mediums. Such unofficial directories contain many mistakes in telephone numbers, names and addresses, and do not include the listings of all our subscribers. Their use often causes much annoyance because of wrong numbers secured thereby and renders our service less efficient in many ways.

"The Bell telephone directory, the only authorized list of our subscribers, is corrected, published and issued three times a year in order that our customers may have an accurate and recent list to consult, while the unauthorized issues gotten out by advertising promoters are generally issued but once, and then left in use indefinitely.

"Your co-operation in refraining from any use of any other than our official directory or in any way lending your support to an unauthorized list is respectfully requested in the interest of good service."

The Smallest Company

The smallest employer of labor in Montana enrolled under the provisions of the compensation act is the Midway Telephone Company of Savage, Richland county. Its monthly payroll is $2 a month, upon which it will pay a premium of 3 cents a month. The cost of looking after the account is estimated at a dollar a month.

Should the lone lineman employed by the company about four hours each month be killed while on duty, his heirs would receive $4,000.

Galesburg's Armored Cruiser

E. E. Elwert, city foreman for the Galesburg Union Telephone Company, Galesburg, Ill., is all ready for the call to arms. Ed took the box off the rear of one of the flivver trucks the company has and fitted thereon a young cannon; said cannon is made from an old piece of telephone pole which has the center drilled out. A ramrod in the hole makes the artillery complete. When asked the idea of this splendid outburst of preparedness, he said it was a submarine. As yet no reports of the sub climbing telephone poles has been reported, but Ed promises faithfully he will accomplish that.

The Item of Going Value

A Separate Concurring Report to the Missouri Public Service Commission

BY JUDGE JOHN KERMISH

IN a recent rate case the Public Service Commission of the state of Missouri announced the policy that

The commission will not attempt to fix a separate and distinct item for going value in these cases, but will take into account the fact that the plant was in successful operation as a going concern, as was stated by the United States Supreme Court in the case of Cedar Rapids Gas Company *v.* Cedar Rapids, 223 *U. S.* 655, 669, and in so doing believes that going value is given the consideration it deserves in finding the present value of defendant's properties for rate making. Des Moines Gas Company *v.* Des Moines, *supra.*

The two cases cited in the above excerpt lend no support to the proposition that a separate finding should not be made as to the element of going value. In each case the appellant contended that in fixing the value of its property no consideration had been given to the item of going value. This value as defined by the court in the Des Moines case is the "value in an assembled and established plant doing business and earning money." Passing upon the question thus raised on appeal, the court held, as stated in the Des Moines case, that,

When, as here, a long established and successful plant of this character is valued for rate-making purposes, and the value of the property fixed as the master certifies upon the basis of a plant in successful operation, and overhead charges have been allowed for the items and in the sums already stated, it cannot be said, in view of the facts in this case, that the element of going value has not been given the consideration it deserves, and the appellant's contention in this behalf is not sustained.

It is apparent that the court was not concerned with the form of allowing going value, whether separate and distinct or otherwise, but rather whether in fact this value had been recognized and allowed in any form by the trial court.

In Omaha *v.* Omaha Water Company, 218 *U. S.* 180, reviewing the action of a board of appraisers of a waterworks plant, it appears that the appraisers under direction of court were required to report the separate elements making up the value of the property, and, complying with the order, made a separate finding for going value. The court, *l. c.* 202, said:

The appraisers in making their estimate of valuation included $562,712.45 for going value! This separation of an element contributing to the value of each tangible part was done because required to be done under an order made in the Circuit Court in a suit in which the water board of the city of Omaha was complainant and the members of the board of appraisers and the water company were defendants. The object of that suit was to instruct the appraisers in respect to the mode and manner in which they should proceed. An order resulted which required the board to report the separate elements making up the aggregate value of the plant.

The appraisal of the board, including going value, was sustained upon certiorari in the Supreme Court. A distinction has been made between the Omaha case (a sale case) and a rate case. See McGregor-Noe *v.* Springfield Gas & Electric Company, 1 *Mo. P. S. C.* 468, and attention is called to this fact by the opinion in the Omaha case. However, as it has since been decided in the Des Moines case, *supra*, that going value, where the plant is in successful operation, is an element of value which must be allowed in a rate case, it is just as important to make a separate finding in the one case as in the other.

The law requires that this Commission in ascertaining the value of an electrical corporation "shall make and file its findings of fact in writing upon all matters concerning which evidence shall have been introduced before it which in its judgment have bearing on the value of the property of the gas corporation, electrical corporation or water corporation affected. Such findings shall be subject to review by any circuit court of this State, in the same manner and within the same time as other orders and decisions of the Commission." (See section 78, subsection 2.)

The finding made herein in response to this requirement so far as material here, is as follows:

The Commission further finds that the fair present value of all the properties of the Kansas City Electric Light Company, defendant, * * * considering said properties as in successful operation, including all elements of value, tangible and intangible, and upon full consideration of all the evidence and all the matters having bearing upon value, to be the sum of $5,250.00, * * * .

The objection of the writer to this finding is not only that it does not "fix a separate and distinct item for going value" but that in order to avoid doing so it of necessity also avoids making a finding as to the value of the physical property—the "bare bones" value—otherwise the intangible value would be disclosed by deductng the physical from the total. So that, notwithstanding the requirements of the statute and the detailed consideration of the several items of value in the report herein, neither the litigants nor the court on review can know the finding or conclusion of this Commission as to the value of any one item or class of property, tangible or intangible, with the single exception of working capital, which is allowed in the sum of $461,438. And it is difficult to understand why the Commission should have made a definite finding as to working capital instead of grouping it along with going value and other items included within the language "all elements of value, tangible and intangible." Upon this single item of working capital the litigants are informed as to the finding of the Commission, and the court on review can see whether the finding so made is reasonable.

The report quotes from the case of Commercial Club *v.* Terre Haute Waterworks Company, *P. U. R.* 1916 *B* 180, in which quotation the following occurs:

There can be but little complaint from either of the litigants if the going value of the Terre Haute Waterworks Company is estimated at $80,000.

Whether the litigants were satisfied with the amount thus allowed for going value or not, they at least knew what the Commission did find, and if not satisfied, were in a position to have surh finding reviewed by the court.

It is well recognized that on either the original cost or reproduction theory the estimates of the expert witnesses as to the physical property are in no way influenced by the fact of the successful or unsuccessful operation of the plant. And if it should be found as a fact that a plant was not in successful operation (not due to unjust restrictive regulation) and therefore without going value, as in the St. Joseph Gas case, 3 *Mo. P. S. C.* 403, the Commission would then be required to fix the value of the physical property. Can we not do so equally well when conditions justify a finding of going value?

The question of a separate finding of going value was given consideration in the recent case of Peck *v.* In-

dianapolis Light & Heat Company, *P. U. R.* 1916 *l. c.* 477, in which the Commission said:

It is not likely that the question of "going value" was seriously presented to the court in that case. The opinion, however, stands as a warning to the Commission that there is such a thing as "going value" to be reckoned with, and that it does not depend wholly upon early losses in the operation of the plant, but that the fact that the property "is a live and going concern" gives it a value above the value of the same plant if it were not a "live and going concern." The court of appeals of New York not only reversed the Public Service Commission of New York by holding that "going value" must be allowed, but declared that it should be found as a separate item, and should be so set forth in the valuation fixed by the Commission. On the other hand, the supreme court of Wisconsin holds that it is impossible to differentiate the item of "going value" from the structural value of the property, and that the "going value" should not be set forth as a separate item, and that it cannot be ascertained with such precision as to enable a commission to set it forth as a separate item. The view of that court is that it is a fact to be considered, to be reckoned with, and taken into consideration, in addition to the structural value of the property, and that such an allowance must be made.

The struggles of the commissions, differing in conclusions touching this subject as they do, the irreconcilable conflict in the views of the judges of the courts of the last resort, demonstrate beyond controversy that the whole theory of arriving at the value of the property of a public service corporation is in a developing stage.

Neither the courts, the commissions, engineers, nor the economists have arrived at any set formula or precise rule by which this value is to be determined. The determination of a fair value must ultimately rest upon the judgment of the Commission, after a consideration of the cost of reproduction less depreciation, the original cost plus all additions and betterments, and the value of the stocks and bonds, the earnings and many other things. One of the other things that must be given significance is the history of the plant itself—its successes and failures, its profits and losses, whether it has a monopoly or must face competition. We say, that each of these items must be given weight.

It is our judgment that 400,000 would be a fair and liberal allowance for the item of "going value" in this property.

The New York case above referred to is the well known case of People *ex rel.* Kings Co. L. Co. *v.* Willcox, 210 *N. Y.*, in which the court, after citing with approval Public Service Gas Company *v.* Board of Commissioners, 87 *Atl. Rep.* (*N. J.*) 651, in which an allowance for going value by the Commission in the sum of $1,025,000 was approved by the Supreme Court of New Jersey, said (*l. c.* 492.):

It may be conceded that going value has no existence apart from tangible property and that commercially there is but one value, that of property as a whole, but as the rate cannot be made to depend upon the exchange value, which would in turn depend upon the rate, it would seem to be necessary to appraise the physical property and the going value separately, and, of course, that is the case if the cost of reproduction rule be adopted.

Although the Indiana Commission in the above discussion contrasts the rulings of the states of Wisconsin and New York as to the finding of a definite sum for going value, and concludes by making a definite finding in accordance with the New York rule, it is to be noted that Wisconsin has not always followed the rule of indefiniteness. (See Re Falls Light & Power Company, *P. U. R.* 1916 *D.* 151; Oshkosh Waterworks Company *v.* Railroad Commission, *P. U. R.* 1915 *D.* 336.) In the case first cited, decided less than a year ago, the Commission *l. c.* 164, said:

Considering the history of this plant and other and similar plants, and taking into consideration all the evidence on this point, we find that the going value ought not to be less than $1,500 nor more than $2,000.

In the Oshkosh case, *supra*, the court said (*l. c.* 342, 344):

One thing is evident. The Commission either allowed $54,000 for reproduction cost of paving not disturbed, and about $14,000 for going value in their final award, or else they disregarded the item of $54,000 and allowed about $68,000 for going value.

An elimination of the item $54,000 results, as before stated, in an allowance of about $68,000 for going value. Under the evidence such sum is reasonably adequate. If the Commission erred in allowing only $14,000 for going value, such error was cured by its allowance of $54,000 for reproduction cost of paving not disturbed. If it did not allow the $54,000 item, then it allowed $68,000 for going value. In either case the plaintiff was not prejudiced.

No more striking illustration than the foregoing could be given as to the uncertainty arising from the action of a Commission in obscuring its finding as to the physical or intangible value of a plant. Courts should not be required to resort to speculation and inference in order to determine whether or not the allowance for going value is reasonable.

In the early history of public utility rate regulation cases, it was decided by the courts that no intangible franchise value should be allowed, unless in a case where payment had been made therefor, nor for the element of good will. There is so close a relationship between good will and going value, as the latter is now recognized, that commissions and courts were long disposed to disallow any intangible value in a rate-making case, though allowing it as an exchange value. This was the condition of the law even since the organization of this commission. (See McGregor-Noe *v.* Springfield Gas & Electric Company, 1 *Mo. P. S. C.* 468; In re Kansas City, Clay County & St. J. Ry. Co., 2 *Mo. P. S. C. l. c.* 64) While not allowing an intangible value, commissions and courts, in order that it should appear that nothing had been overlooked, were disposed to use vague and all-inclusive terms as to values. Then we saw through a glass darkly, but now after the element of going value in a proper case has been definitely recognized by the highest court of the land, conditions are entirely changed. It is now a question of fact upon which a finding should be made whether the plant is in successful operation, earning money.

If so found, and the Commission estimates the reasonable return of the company at 6½ per cent, while the company borrows money at 5 or 6 per cent, as in this case, then it must follow with as much certainty as anything in commercial affairs that the margin of return over the current rate of interest, together with the fact that the business has become established and is thus earning money, will give to the plant an intangible value on the market, making the total value substantially above that of the physical value. Nor is the difficulty in estimating the reasonable value of this item an insuperable obstacle. True, differences of opinion will arise as to what would be a seasonable going value in such a case, but such differences exist and are encountered in every valuation case and as to every class and character of property. In any event, other commissions and this Commission have estimated the reasonable value of this item, and if the finding so made is unjust or arbitrary as to the utility or the public, either or both may have recourse to the courts upon a record, which frankly and definitely discloses the findings made and conclusions arrived at.

Among the cases in which a separate finding, either as to physical or intangible values, or both, has been made, in addition to those already referred to, the following are cited: City of Joplin *v.* Home Telephone Company, 4 *Mo. P. S. C.* 64; In Re City Water Company of Sedalia, 4 *Mo. P. S. C.* 140; Marshall *v.* St. Joseph Gas Company, 3 *Mo. P. S. C.* 403; Re Mountain States Telephone & Telegraph Company (Colo.) *P. U. R.* 1917*B*, *l. c.* 287;

Arvada *v.* Arvada Electric Company (Colo.) *P. U. R.* 1916*F*, 1108; Re Richmond Light, Heat & Power Company (Ind.) *P. U. R.* 1917*B*, *l. c.* 307; Jones *v.* Connersville Telephone Company (Ind.) *P. U. R.* 1916*F*, 1108; Commercial Club *v.* Citizens Gas & Fuel Company (Ind.) *P. U. R.* 1916*B*, *l. c.* 22; Re Peru Heating Company (Ind.) *P. U. R.* 1915*E*, *l. c.* 508; Ft. Scott Gas & Electric Company *v.* Ft. Scott (Kan.) *P. U. R.* 1915*B*, *l. c.* 500; Leavenworth *v.* Leavenworth City & Ft. Leavenworth Water Company (Kan.) *P. U. R.* 1915*B*, *l. c.* 636; Re Chespeake & Potomac Telephone Company (Md.) *P. U. R.* 1916*C*, *l. c.* 1003, *et. seq.*; Mangum v. Mangum Electric Company (Okla.) *P. U. R.* 1916*E*, *l. c.* 779 Gately & Hurley *v.* Delaware & Atlantic Telephone & Telegraph Company, 1 *N. J. P. U. R.* 519; White *v.* Westchester Lighting Company, 4 *N. Y. P. S. C.* (2nd D) 269, *l. c.* 322; Re Federal Telephone & Telegraph Company, 4 *N. Y. P. S. C.* (2nd D.) 184, *l. c.* 189; Pioneer Telephone & Telegraph Company *v.* Westenhaver, 29 Okla. 429, 118 *Pac.* 354, 38 *L. R. A.* (*N. S.*) 1209; Public Service Company *ex rel*, Seattle *v.* Seattle Lighting Company (Wash.) *P. U. R.* 1915*B*, *l. c.* 140; Beloit *v.* Beloit W., G. & El. Co. (Wis.) *P. U. R.* 1915*B*, *l. c.* 1010; Venner Company *v.* Urbana Waterworks Company, 174 *Fed.* 348, 352; Des Moines Water Company *v.* Des Moines, 192 *Fed.* 193, 197; And in sale cases: Omaha *v.* Omaha Water Company, 218 *U. S.*, *l. c.* 202, 54 *L. ed.* 1001, 48 *L. R. S.* (*N. S.*) 1048, 30 *Sup. Ct.* 615, affirming 162 *Fed.* 225; Norwich Gas & Electric Company *v.* Norwich, 76 *Conn.* 565, 582; Gloucester Water Supply Company *v.* Gloucester, 179 *Mass.* 365, 383; Galena Water Company *v.* Galena, 74 *Kan.* 644, 646 *et seq.* And in security issue cases: Re Indianapolis Telephone Co. (Ind.) *P. U. R.* 1916*D*, *l. c.* 516; Re North Michigan P. C., 19 *A. T. & T. Co., Com. L.* 244.

While different theories were adopted and applied in the above cases as a basis for ascertaining going value, yet a definite finding is as important under one theory as another, certainly so as to physical value, and, in the opinion of the writer, the policy adopted in this case of using vague and general terms instead of definite findings is not in keeping with the spirit of the law under which we are acting, and will not prove satisfactory to the parties in interest or to the court on review

Beaumont, Texas, Merger Probable

The proposed merger of the properties of the Beaumont Telephone Company with those of the Southwestern Telephone & Telegraph Company and the operation of only one exchange in Beaumont, Texas, seems in a fair way to obtain sanction of the city council, and likewise to be agreed upon by the two companies. B. S. Young, of Ada, Ohio, general manager of the Beaumont Telephone Company, who it is also understood is acting for the Southwestern in negotiations looking to the consolidation, has discussed the merger with officials of the Southwestern at Dallas. Mr. Young was in conference with members of the city council. Previously he had appeared before the council in open session and the proposed ordinance-franchise which is to perfect the merger was introduced and referred to the ordinance committee. Mr. Young and members of the committee and other councilmen were present.

Accordling to the draft of the ordinance it calls for little change from the franchise under which the Southwestern is now operating. There is only one question of any moment, apparently, in the ordinance which differs from the old franchises. That is the provision which will permit the company operating under the new franchise to charge $5 instead of $4 for the business telephone. There is no change proposed from the $2 rate for the residence telephones. So far as is known there seems no opposition to the increased charge, although this matter has not been publicly discussed, as the ordinance has not yet been reported out of the committee.

The life of the proposed franchise is eighteen years, beginning with May, 1910, and expiring May, 1928. The present franchise of the Southwestern expires on that date. Save a few changes to meet local conditions the franchise is similar to the one recently adopted in Austin when the telephone companies of that city were merged. Of prime importance locally is the provision which binds the operating company to erect a suitable telephone building and install new exchanges. This latter would of necessity have to be done any way, as in the event of merger it is proposed to operate both of the present exchanges up until the date the new exchange and building is completed and ready for occupancy. There would be no interruption of service.

The ordinance committee will report on the measure at the next meeting, and it is understood both the companies expect to be in position to accept the agreement of the council to the merger just as soon as it is granted.

Sunny on Universal Service

Bernard E. Sunny, president of the Chicago Telephone Company, gives his unhesitating approval of the movement for universal military service.

"We are all Americans and all true Americans are in favor of universal training," he said. "The people of the country should respond at once to the call. "The nation had no choice in the matter of going to war with Germany. It had to do it!

"The men of this nation can have no choice as to serving their country in the war. They must do it.

"*All* of our nation is in the war, which means that *all* of our men must be.

"The conceded failure of the volunteer system everywhere takes from it any debatable value in the face of the universal experience that compulsory service is necessary.

"The debate on war or no war is closed. We are in the war!

"A debate on voluntary or compulsory service is useless if we would win, and win we must and will.

"The President is right and he should be unanimously backed up in his demand for compulsory service."

No Referendum Probable in Dallas

Since the Dallas Automatic Telephone franchise carried by an overwhelming majority it is not likely that any attempt will be made to start a referendum petition in the Texas city on the valuations. Should a referendum be started on this question it would mean a vote on this franchise and the probable merging of the local Automatic and Bell properties next September.

The period of ninety days is allowed for the making of valuations of telephone properties. Then comes a period of sixty days for an initiative and the time allowed for calling an election.

It is likely that the city will go to no great expense in securing experts for the valuation of telephone properties under the Lawther administration. Possibly Dallas accountants will be retained to check up the figures already presented by the Automatic company. Dr. Bemis will not get the valuation contract.

United States Independent Telephone Association

SIGNAL SERVICE RESERVE CORPS.

That part of the Signal Corps in which is is desired that experienced telephone men shall enlist consists of Telegraph Battalions and Field Battalions. To the Telegraph Battalion is assigned the duty of establishing and maintaining the telephone and telegraph systems between the Brigade and Division Headquarters and the base of operations and other systems that might be classed as semi-permanent.

TELEGRAPH BATTALION.

The Telegraph Battalion is as much a telephone battalion as a telegraph. Each Telegraph Battalion consists of two companies and each company is organized into two sections: two telephone and two telegraph.

The officers of a Telegraph Battalion are: a major, two captains and six first lieutenants. A major receives $3,000 a year, a captain $2,400, and a first lieutenant $1,700. All officers provide their own uniforms, personal equipment and food. Of the lieutenants, one is assigned to duty as the battalion adjutant and one as supply officer. There are four master electricians to a battalion. A master electrician receiver $75 per month. There are 15 first sergeants who receive $45 per month. There are 23 sergeants who receive $36 per month, and 34 corporals who receive $24 per month. Four cooks are bith a battalion. They receive $30 per month. A first class private, of whom there are 100, receives $18 per month. There are also 27 privates who receive $15 per month. Of these, 3 are assigned to duty as clerks and orderlies. There are six "sanitary troops" with each battalion; a captain, sergeant and five privates. All enlisted men are provided withe food, clothes and equipment by the government.

There are thus 10 officers and 215 enlisted men in each Telegraph Battalion.

FIELD BATTALION.

In a Field Battalion there are fourteen officers and 245 enlisted men, including attached sanitary troops. To a Field Battalion is assigned the duty of keeping the outposts and moving troops in communication with the various headquarters and with each other. The Field Battalion has as commissioned officers one major, three captains and nine first lieutenants. The Field Battalion is divided into three companies: a wire company, a radio company and an outpost company. The wire company is organized into two platoons of two wire sections each. The radio company is organized into four pack radio sections and one wagon radio section. The outpost company is organized into four platoons.

The pay of officers and enlisted men in the Field Battalion is the same as in the Telegraph Battalion.

WHERE TO APPLY.

Until May 1, 1917, all States east of Ohio, south of the Ohio River and east of the Mississippi, to the Department Signal Officer, Army Building, New York City.

After May 1, 1917, this department will be subdivided and applications should be addressed in Maine, New Hampshire, Vermont, Massachusetts, Connecticut and Rhode Island to Department Signal Officer, Northeastern Department, Boston, Massachusetts.

In New York, Pennsylvania, New Jersey, Delaware, Maryland, West Virginia and Virginia, to Department Signal Officer, Eastern Department, Army Building, New York City.

In North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi and Tennessee, to Department Signal Officer, Southeastern Department, Charleston, S. C.

The Southern Department consists of Arkansas, Louisiana, Oklahoma, Texas, New Mexico and Arizona. Applications should be made to Department Signal Officer, Fort Sam Houston, Texas. The Western Department consists of California, Nevada, Utah, Oregon, Washington, Idaho and Montana. Applications should be made to Department Signal Officer, Chronicle Building, San Francisco, Cal.

The Central Department consists of Ohio, Kentucky, Indiana, Michigan, Wisconsin, Illinois, Missouri, Iowa, Minnesota, North Dakota, South Dakota, Nebraska, Kansas, Colorado and Wyoming. Applications should be made to Department Signal Officer, Federal Building, Chicago, Ill.

Detailed information as to the Signal Corps will be issued by the Chief Signal Officer, War Department, Washington, D. C.

Inquiries as to requirements, qualifications, etc., will be answered on behalf of the Independent telephone companies by F. B. MacKinnon, vice-president of the United States Independent Telephone Associaion, 527 Colorado Building, Washington, D. C., representative of the Independent companies on the Committee on Communications of the Council for National Defence.

European Telephone Development

Translations from the Foreign Press and Communications from European Engineers

BY FRED W. SCHOLZ

DETERMINING the number of selector switches needed in an automatic telephone system can only be accomplished by the use of the theory of probabilities. The problem to be solved resolves itself into the following: To give to a subscriber at any given time the practical certainty to find one connector switch or several selector switches and the desired connector switch open for his call. The theoretical certainty of this problem is possible only, if each subscriber has at his disposal a complete series or set of selector switches. But economically and materially it is impossible to satisfy this requirement. It is necessary then for the sake of our argument to assume the hypothesis that among N subscribers, say 100, there will very rarely, perhaps once in a thousand times, occur the condition that there are more than n numbers speaking simultaneously. Even though each subscriber of the group N can choose at any instant among the n number of switches, reserved to this group, it will not happen more than once in a thousand times, that a subscriber calling for a number will find all of the n number of switches busy. The service is therefore satisfactory for all practical purposes.

But how to determine this number n? Direct observation will always give us the answer, if we count the simultaneous connections a sufficiently large number of times. This number would have to be very large, however, for the possibility that more than the n number of switches are busy, a state which is to be avoided by all means, this would have to occur often enough during the series of observations, to allow a valid conclusion if these experiences are to be valuable. Moreover this test cannot be made in any given automatic system, until the latter is actually installed, for if made with the manual system, the conclusions are not valid for the automatic. In manual systems, as a matter of fact, the incoming calls per hour have to wait until the operators are free to answer them. If, for example, we assume the case of a single operator taking care, without aid, of 100 subscribers, the calls might well come in at regular set intervals, but the making of connections will follow a much more regular law, since between the start of two calls there is bound to be an interval of time needed for the operator to finish her first call before turning to this one. In the automatic system, on the other hand, one cannot figure on any waiting time for the subscriber, without noting that he begins to work his switch dial and call for a switch, before the latter is free for a call. Consequently the making of connections must follow immediately after the call by the subscriber and we are therefore forced to treat the question *a priori*, basing it on the theory of probabilities.

Christensen Formula: This question was studied in detail by Christensen a number of years ago. He gives for the number x of simultaneous connections to be expected the equation: $x = y + n\sqrt{y}$, where y is the average number of communications, which is easily determined as follows: Each subscriber, according to statistics, which are valuable no matter what system was employed before, makes on the average a calls during the busiest hour of traffic, each conversation lasting m minutes. If we call N the number of subscribers, whose lines have access to the same set of selector switches, and $S = aN$ the number of calls, the average number of subscribers speaking simultaneously will evidently be $y = \frac{Sm}{60}$ since Sm is the total number of minutes of conversations per hour. n is a function of the proposed probability P, namely, that the number of simultaneous calls be at most equal to x. n is also, as Christensen states, a function of y, which tends to approach a constant only for great values of y.

However, it is easily shown that one cannot confirm the law of variation for x by considering y merely as an independent variable. First of all, we cannot state that the theory of probabilities is directly applicable to the variation of the number of simultaneous calls; it is not clear, particularly, that, if 10 is the average, the values 9 and 11 are not equally probable. Moreover, y itself is a function of the two quantities S and m, and it is clear that the law of variations will not be the same for example, for $S = 200$, and $m = 1$, as for $S = 20$ and $m = 10$, although Sm may be the same. It is sufficient to state that in the second case, if $x = 21$, one is certain to meet all needs, since there are more selector switches than connections to be made, although this would not be sufficient for the first case.

It is therefore necessary to go back to the real statement of the problem, to the phenomenon which is shown in following a law that is entirely unknown to us, namely the calls made by the subscribers. Suppose N is the number of subscribers that have access to the same group of selector switches, and that t is the average time during which any of them speak on the telephones during the busiest period in the day, the time being expressed in fractions of an hour. The average number of simultaneous communications is as we have just seen, $y = Nt$. At any moment the probability that a certain subscriber speaks is t, and the probability that he does not speak is $1-t$.

Law of Bernouili: We can also try to apply the law of Bernouilli, by reasoning as follows: Let us represent each subscriber by a cube, having $\frac{1}{t}$ faces, of which l is considered as favorable and the others unfavorable. Let us throw the cube or dice in the air: the probability that it will fall on the favorable face is equal to that for the subscriber who speaks. If we repeat the operation X times for the N subscribers, we will have X series of N trials, and the average for each series of favorable cases, that is, for simultaneous calls, is $Nt = y$; for the X series we will have X values of number of favorable cases, which will be grouped about Nt, and the law of Bernouilli is the law of their distribution when N is very large. The tables of Bernouilli give directly the probability of an error $\frac{x-y}{N}$ in terms of the relation of this error to the normal error $e = \sqrt{\frac{2t\,(1-t)}{N}}$. If we call $\frac{n}{\sqrt{2}}$ the value of this proportion read off from the tables for a given probability, then we will have:

$$\frac{x-y}{N} = \frac{n}{\sqrt{2}} \sqrt{\frac{2t(1-t)}{N}}. \quad x = y + n\sqrt{Nt(1-t)} = y + \sqrt{y(1-t)}$$

We thus obtain an equation which recalls that of Christensen, but with the introduction of the factor $\sqrt{(1-t)}$, very near to 1, and therefore negligible in practice for subscribers' lines that are used very little. This will not be the case if we apply the same equation to the selection of the second selector on the basis of the first selector switches, for example.

Unfortunately the most ordinary values of N in the automatic system are not sufficiently large. The number of subscribers having access to the same set of primary selector switches or the second selectors may run from 50 to 100, at most to 200; under these conditions the tables of Bernouilli do not give sufficiently accurate results.

Developing the theory: We must therefore take up the entire question from another angle. Let us consider N subscribers. The probability that any one of them does not speak is, in accordance with the theory of probabilities, $(1-t)^N$. The probability that a single subscriber speaks, is equal to the sum of the probabilities for subscriber 1 speaking and for the subscribers 2, 3, 4 . . . $N-1$, N not speaking; for subscriber 2 speaking and for subscribers 1, 3, 4 . . . not speaking, for subscriber 3 speaking . . . etc. All these probabilities are equal to each other and are equal to $t(1-t)^{N-1}$; their sum is then $Nt(1-t)^{N-1}$. The probability for two subscribers speaking is equal to the sum of the probabilities that subscribers 1 and 2 speak and that subscribers 3, 4 . . . N do not speak and so on. All these probabilities are equal to $t^2(1-t)^{N-2}$ and their number is equal to the number of combinations of N objects, taken two by two, i. e. $\frac{N(N-1)}{1\cdot 2}$; the probability that two subscribers speak is then $\frac{N(N-1)}{1\cdot 2} t^2(1-t)^{N-2}$. We easily recognize the progression of terms:

$$(1-t)^N,\ Nt(1-t)^{N-1},\ N\frac{(N-1)}{1\cdot 2}(t^2\,1-t)^{N-2},$$

$$\ldots\ldots\ \frac{N(N-1)}{1\cdot 2}\cdot\frac{\ldots}{\ldots}\cdot\frac{\ldots}{\ldots}\cdot\ldots\cdot\frac{N-p+1}{p}\,t^p(1-t)^{N-p}$$

These are the successive terms after developing the binominal: $[(1-t)+t]^N$.

The probability that there will be p or less than p number of subscribers talking simultaneously is therefore equal to the sum of $p+1$ the first terms of developed equation, and when stopping at the term to which this sum is the nearest, or immediately near $\frac{999}{1000}$ we will have the number p of selectors which it will be necessary to install.

This method does not lend itself readily to the use of fraction values of p. In the following table are given the two values of the probability, which relate to $\frac{1}{1000}$ for $N=100$ and for different values of t.

The values here obtained differ slightly from those given by Christensen; in practice these can be used, when t is small enough, with excellent results. For $N=50$ one will find for the same value of Nt and of p that the probabilities are slightly smaller than for $N=100$; thus for $N=100$ and $t=\frac{1}{60}$, we have $\Phi_7=0.0016$, while for $N=50$ and $t=\frac{1}{30}$ we have $\Phi_7=0.0013$. For $N=200$ one would find the probabilities a little greater for equal values of Nt and p.

TABLE OF PROBABILITIES FOR SELECTOR SWITCHES.

t = average time of conversation of each subscriber during busiest hour.	p = Number of Selectors Installed	Φ = Probability that there are more than P subscribers speaking	Ψ = Coefficient of average occupation of selectors $\Psi=\frac{Nt}{p}$
$\frac{1}{100}$ = 36"	5	0,00344	0,2
	6	0,00054	0,167
$\frac{1}{80}$ = 45"	6	0,00168	0,208
	7	0,00028	0,178
$\frac{1}{60}$ = 1'	7	0,0016	0,238
	8	0,00032	0,208
$\frac{1}{50}$ = 1'12"	7	0,0041	0,286
	8	0,00096	0,25
$\frac{1}{40}$ = 1'30"	8	0,0037	0,312
	9	0,00094	0,277
$\frac{1}{33,3}$ = 1'48"	9	0,00322	0,333
	10	0,00088	0,3
$\frac{1}{30}$ = 2'	10	0,00191	0,333
	11	0,00052	0,303
$\frac{1}{25}$ = 2'24"	11	0,00225	0,364
	12	0,00068	0,333

Case where the number of switches per group is greater than 10: If the calculation gives a number greater than 10 for p we meet a difficulty. In the automatic systems, at least in those derived from the Strowger type, the selection can only be for 10 lines. If one would wish to use 14 selectors for every 100 subscribers, one would be unable to give to all of the latter access at any time to any of the 14 selectors. Likewise, if it should be necessary to use 14 connectors per hundred subscribers, each of the last selectors could not have access to any of the 14 connectors.

Common Lines: Aside from the use of second selectors, of which we will speak later, the following scheme can be used. Let us consider one part of N lines, which we will call the "testing or searching" lines (subscribers' lines or selectors) and the other portion the p lines, the "tested lines" (selectors or connectors). If p is found between 10 and 20, say at 14, we will divide the N testing-lines into two equal groups; but we will not divide the p tested-lines in the same way, in order to obtain a half of each group $\frac{N}{2}$, for with $p=7$, for example, we have seen that the average coefficient of permissable conversations for the tested lines was far inferior to the factor it took, when $p=10$ and consequently these switches will be less efficiently utilized. Of the 14 lines, we will attach 4 to the first group $\frac{N}{2}$, 4 to the second group $\frac{N}{2}$ and the 6 remaining ones will be common to the two groups, in such a way, that each of the "testing-lines" will always have access to 10 switches.

In this case the preceding calculation is not applicable, for it is easy to see that it may happen that one line of the first group $\frac{N}{2}$ finds the 10 lines which it tests busy, since the 4 others, attached directly to the second group, may not be available. To reduce the probability that this may happen to a minimum, one connects the multiple lines adjoining the tested switches by way of the contacts of the testing-lines, in such a way that the 4 lines belonging to each group are always tested first and the 6 common lines tested afterwards.

It is clear that we can in this way obtain for an equal

probability, an average coefficient of occupation of the tested selectors equal or superior to that which would be the case, if these selectors were in sets of 10 per group N. But evidently it is lower on the other hand than it would be if the N number of testing-lines could each have access to p selectors to be tested. It seems difficult enough to calculate the true value, but it is easy to see that it must be slightly greater than the admissable coefficient of occupation (busy selectors), when p=10, varying as we have seen from 0.30 to 0.32, as $\Phi < \frac{1}{1000}$

If p is found between 20 and 30 we will divide N into 3 groups, using a similar system, as just described, etc.

Number of First Selectors: We will now consider the number of first selectors, when there are no second selectors. The selectors of the Keith system (Automatic Electric Company) are grouped by 25, 50 or 100, each group being worked by a special master switch. We will now refer back to the results calculated for N=100, t being given by the statistics of the local exchange. If $p < 10$, we will equip p lines of the first selectors per hundred: if p is greater than 10, we will halve the principal switch of the 100-group and will form two groups of 50: to each of these two groups we will assign p-10 special lines and the 20-p remaining lines will remain common to the two groups (this part of the system being rather incomplete in the installation of automatic telephony at Nice). In this case, being given the working of the master switch, it is impossible to test the special lines belonging to each group for each group of 50 in every instance on first trial, and the average coefficient of occupation (busy selectors) will not be very much higher than it was when p=10, α being=0.32 (for N=50 and t=3′50″). We deviate then in this case from this value of α in order to deduce the necessary value of p.

In the systems analogous to the Siemens and Halske automatic telephones, where the selectors are independent of each other, it is possible theoretically always to take N large enough, if t be small enough, so that p equals 10, and thus assure the first selectors of a maximum coefficient of occupation, varying between 0.30 and 0.32, depending on the magnitude of N. But practically, owing to the cost of multiple wiring increasing with N, it is not possible to modify all of the system to meet the varying conditions of traffic, so that one takes values that are equal to N=100, 150, 200. Thus, when N=100 for example, we find a number of first selectors greater than 10; we can likewise proceed to the division of the lines between two groups with special lines belonging to each group and lines common to all groups. If in these systems, the selector returns each time to its rest position, it is possible to have each selector start at the subdivided lines and it is possible to obtain an efficiency of about 0.35.

Number of second, third . . . . selectors: This number is worked out along the same lines. For example, if we wish to find the number of second selectors, which must be installed for calls by subscribers numbered from 2000 to 2999, we take for N the number of first selectors, for t the value: $\frac{\alpha}{\beta}$ α being the average coefficient of occupation of the first selectors and β the ratio of the total number of calls of the exchange or the city to those destined for subscribers 2000-2999. Then the equations given before are applied. As p will in nearly all cases be greater than 10, except in very small exchanges, it will be necessary to divide N into a certain number of groups, and proceed as before to the installation of special lines for each group and lines common to two of them or even common to a greater number of groups. The theoretical calculation cannot be applied in this case, but we know that the average coefficient of occupation, for a probability always equal to the same number $\frac{1}{1000}$, cannot differ much from the values 0.32, 0.36 or 0.37. We take 0.35 as an average in the majority of cases.

Number of Connectors: The connectors having a field open to them amounting to 100 lines at the most, in systems based on Strowgers, that number can be calculated, as was seen above, by taking for N the value 100 and for t the average time during which each subscriber is busy as the called-subscriber. If we find $p < 10$, we will equip p connectors per 100; if $p > 10$, we estimate p by the same considerations as before, using as coefficient of occupation 0.35, whence we have $p=\frac{Nt}{0.35}$

In the McBerty system, where the field of exploitation for the connector is 200 lines and where each selector can choose among 20 lines, we find that for N=200 and $\Phi_{20}=\frac{1}{1000}$, t=about 2′45″, which means that 20 connectors are sufficient to take care of the service for 200 lines, where each speaks on the average 2′45″ during the hour of heaviest traffic. The coefficient of occupation for the connector is 0.46, which is 50 per cent greater than that in a system of selection of 10 lines.

In this same system and for the same reasons we can figure out a coefficient of occupation for second selectors and third selectors, the last being between 0.45 and 0.5, when the 20 directors can be utilized.—M. Milon, *Annales des Telegraphes et Telephones.*

TELEGRAPH AND TELEPHONE SERVICE IN THE WARRING COUNTRIES.

An interesting little resumé is given in a recent number of *Annales des Telegraphes et Telephones* of the telegraph and telephone service in the territory occupied by the German army for the last 2½ years, and also the new regulations adopted in Germany to offset the scarcity of some of the raw materials necessary for electrical work.

Service in Belgium: The personnel of the Belgium department of telegraphs and telephones had destroyed as much of the equipment as possible, before evacuating the country. The German armies found considerable difficulty in repairing the lines so as to be used for military and hospital communication. The plans and documents of underground telephone cables had either been taken away or so altered as to make them practically useless. Many of the cables and wires were damaged and long sections of overhead wires were found to be down in an indescribable tangle. The switchboards had been entirely demolished or else rendered useless by taking away certain parts. The destruction of the exchange at Bruxelles necessitated installing an entirely new switchboard, which had to be brought from Germany. Since the Germans took possession of the central exchange at d'Anvers two days after the fall of the fortress, they were able to establish communication and start service without much difficulty in that section. In a relatively short period of time the great telephone and telegraph exchanges at Bruxelles, Anvers, Liège, Gand, Charleroir and Verviers were in service again. The telegraphic communication between Bruxelles and Germany is quite considerable, even in normal times, and the Siemens high speed tele-

graph was used during the war. The necessary telegraph and telephone alarm service for the police, the fire department, and the water supply department was soon installed. The telegraph and telephone lines have been rebuilt to a distance of about 48,000 km. (28,800 miles) especially along the chief railway lines. The telegraph system is divided into 27 districts; 58 private exchanges are open for private business; 521 are exclusively for the military administration. Private telegrams of an urgent nature without limit of words are accepted in German, Flemish or French at the rate of 1 franc ($0.20) per series of ten words. Telegraphic traffic is authorized between certain sections of Belgium and Germany. All information relating to troups, military or naval movements is forbidden. The rate for ordinary telegrams ranged from 10 cents, about 2 cents a word, upward, and for urgent messages from 30 cents, about 5 cents a word, upward. The telegraph traffic in private telegrams has developed fairly well, even within Belgium itself, and reaches about 20,000 messages a month.

The telephone service is not open to the public. The number of telephone stations, which was about 50,000 before the war, has dwindled down to 4,700, of which number 1,800 are in Bruxelles, all of them reserved to military and civil officials. The personnel looking after the telegraph and telephone work is German, comprising about 200 operators for telephone and general work, 80 minor officials and 320 telegraph operators, of which number there are quite a few army telegraphers.

Use of Low Grade Copper: As copper of high conductivity has become scarcer and scarcer, rules have been adopted to use low grade copper of lower conductivity, where possible. The regulations are to hold throughout the war and for some time after, until the raw materials can be imported and turned into the proper grade copper wire. The resistance of the new wire to be used for 1 sq. mm. cross section must not be greater than 25 α and the copper must be of a grade having a low conductivity. The same general safety rules and standards for high grade copper are applied to this copper and the current capacities set down in the new rules can be applied over these wires without fear. No more than three conductors may be placed side by side in a cable, for example, as the increase in temperature could not be sustained.

Zinc for Cable Material: Zinc has twice the conductivity of iron wire, is not magnetic and much more flexible; the difficulties of protecting it against rusting are also eliminated. On the contrary, zinc, owing to its mechanical properties, cannot well be used for overhead wires. The resistance of a wire of 1 sq. mm. cross section and of 1000 m. length at a temperature of 15° C. is not greater than 67 α. The temperature coefficient can safely be taken in computations around 0.004. For zinc overhead conductors we have the following intensities of current, that can be used with safety:

Normal cross section of conductor.	*Maximum Intesity in Amperes.*
1 sq. mm.	4
1.5	6
2.5	8
4	12
6	16
10	23
16	33
25	45
35	60
50	75
70	100
95	125
120	145
150	175
185	210
240	245

Simple zinc cables placed underground can be used up to 600 volts and the following table applies to zinc conductor cables:

Cross Section	*Maximum Intensity*	*Cross Section*	*Maximum Intensity*
4 sq.mm.	30 Ampere	50 sq. mm.	135 Ampere
6	40	70	180
10	50	95	205
16	70	120	240
25	90	150	270
35	110	185	305

The current strength in these cables must be kept accurately within the limits mentioned and regulations also demand that no more than two cables be placed side by side in the same cable sheath.

Use of Synthetic Rubber: The lack of natural crude rubber for use in rubber insulated conductors has led to the use of synthetic rubber. One cannot expect as much from these insulated conductors as from the old ones. These also have to be subjected to a special careful treatment, as the synthetic rubber so far has not reached the elasticity that the crude rubber has. During the war and a short time after peace shall have come, the same regulations permit the use of conductors insulated with this material. The test to which insulated wires or cables are exposed requires that the rubber sheath shall have a thickness of at least 1 mm. After having been exposed for at least 5 minutes to heat and then laid two hours in water it must withstand during ½ hour a tension of 1200 volts alternating current at 50 periods.

Requisition of Lead: A document was published some time ago by the German war department, requiring the use of all lead from certain sources for military work. The circular letter reads somewhat as follows:

"The war department has learned that you are in possession of a set of lead storage batteries. The department attaches great importance to the use of the lead in those batteries for military reasons and appeals to your patriotism to deprive yourself of the use of the battery during the war. The department has signed an agreement with the Vienna and Budapest storage battery factories and other manufacturers, whereby these companies will furnish you after conclusion of peace a new battery in exchange for your old one now requisitioned.

"You are requested to kindly inform the above-mentioned factories of your intention to cede the batteries voluntarily in order that these houses may immediately take orders for the delivery of new batteries at the proper time.

"All lead being requisitioned for military use, according to the decree published February 7, 1915, your attention is called to the fact that you are not permitted to sell the lead in your batteries to any but the houses mentioned in this letter who have been commissioned by the government to collect the batteries requisitioned.

"Your attention is likewise called to the fact that in case you refuse to place the batteries at the disposal of the government, during the war, that the department reserves to itself the right to examine whether the disposal of the batteries really stops your business, and in case the examination is to the contrary, you run the risk of having the battery confiscated by way of military requisition."

It is seen in what careful manner the war department asks for the disposal of these batteries. There will be many cases where it will be impossible to get along without the batteries. In such cases the war department after investigation will either leave the batteries intact or else require only a portion of the entire set. There are other sources of lead, which the government can also utilize; thus the lead pipes used for water mains or the lead chambers used in the lead chamber process for the production of sulphuric acid, and also some of the leads used in printing.—*Annales des Telephones.*

History of the Telephone in Hawaii

Island Utilities Commission Report Claims Earliest Competition

THE honor of introducing the telephone into the Hawaiian Islands goes to Senator Charles H. Dickey, who imported a set of instruments from the United States and placed them into use on the Island of Maui, Kingdom of Hawaii, during the early part of the year 1878; this being barely two years after the original patent had been granted to Alexander Graham Bell. In the year 1879, the first telephone company was organized in Honolulu, Kingdom of Hawaii, and incorporated under the name of the Hawaiian Bell Telephone Company, and on December 30, 1880, started service with thirty instruments in operation.

On August 16, 1883, the Mutual Telephone Company was organized, a new telephone plant built and equipped, and in March, 1885, began operation in competition with the Hawaiian Bell Telephone Company. This competition in the telephone business was probably the first in the United States, the fight lasting until August 2, 1894, when a consolidation of the two companies was effected by the Mutual acquiring the control of the Hawaiian Bell. At this time the Bell company was capitalized at $50,000 and had 565 telephones in operation, while the Mutual was capitalized at $79,000 and was giving service to 701 subscribers.

On the amalgamation of the Bell with the Mutual company, the latter company increased its service to 900 subscribers. The switchboards used by these pioneer telephone companies were numerous and various. The Law system was first installed by both of these companies and was changed several times on account of fires and changes in apparatus due to the rapid development and improvement in methods of operation. The Law system was continued until the year 1899, when a change was made to the Sabin Express system, which remained in service until August, 1907, this giving way to the latest Western Electric common battery, lamp signal, full multiple switchboard. This board was in operation for three years, when, owing to the increasing difficulties of supplying telephone service to the cosmopolitan population of Honolulu, it was decided by the directors of the company after a careful investigation that the Automatic telephone gave promises of overcoming the difficulties that were then being experienced in providing a system of telepathy that would meet with the approval of a variety of races of which on Oahu perhaps 15,000 are of English, American and German extraction; 35,000 Japanese, and the remainder divided amongst the native Hawaiians, Chinese, Filipinos, Koreans, Porto Ricans, Spanish and Portuguese; of the white population 6,000 being soldiers in the United States Army barracks.

The company began operations under the Automatic equipment in August, 1910, starting with 1,800 instruments in service, and during the past five years has added an average of over 800 subscribers without employing a single solicitor.

The Honolulu exchange is a two-story and high basement building of fireproof construction, 50 feet wide and 75 feet long. Located in this building are the executive offices, the main automatic switchboard, information and trouble departments, and the city offices of the wireless department.

The telephone equipment located in the building consists of 4,500 automatic switches, with all the necessary wiring, cabling, and apparatus necessary for giving a full automatic telephone service, and every precaution has been taken to have additional parts and duplicate apparatus to insure uninterrupted service.

Located also in this building is the apparatus for the operation of the Denio fire alarm, and the electric clock and time stamp systems.

The Kaimuki Exchange is a new fireproof structure, 36x50, costing complete with installation $33,000. The switchboard will take care of 5,000 subscribers, but the first unit is for 600. There is no additional tariff from Honolulu proper through this board, but, as stated by the company, it is for the purpose of affording better service to the public. The building has been equipped with modern equipment as follows:

A modern switchboard of the Automatic Electric Company's manufacture, and consists of a 600-line Keith individual line board, with all the inecessary apparatus, such as wire, cable, switches, etc., for interconnecting. It is provided also with trunking relays or repeaters for use in connecting the different exchanges of the telephone system on the island of Oahu.

A power plant with all the vital parts in duplicate has been provided, which would otherwise in case of accident necessitate the closing down of the exchange until repairs had been made, or a new unit furnished from Chicago.

The whole equipment is of the latest design and the best procurable.

At the Waipahu Exchange there are three operators and one chief operator on duty. They work eight hours a day, have one hour for lunch. The superintendent receives $100 per month, the chief operator $40 per month, and the three operators $35 per month. The employees are furnished with a modern, well-kept cottage, divided into dormitories, living room, kitchen and dining room. They club together and purchase their supplies in bulk, and their pro rata share of the living expenses amounts to six or seven dollars each per month. The buildings are sanitary, the grounds well kept, and the installation in excellent state of repair.

The equipment consists of one three-position magneto switchboard, equipped with fifty drops for local work, and ten toll lines to Honolulu. This is a recording and dialing exchange, and here are made all the connections from Honolulu for the exchange at Waipahu, as well as the exchanges at Wahiawa, Waialua, and the U. S. Goxernment exchanges at Castner and Schofield Barracks.

At the Wahiawa wireless station and telephone exchange the employees work eight hours and have one hour for lunch. The chief radio operator receives a salary of $120 a month, plus quarters, etc. This exchange is located on a four-acre tract at 886 feet elevation. It is well kept, clean and orderly, and the homes show evidence of good care and proper management. The other two operators receive a salary of $100 a month each, plus furnished bungalows. They are licensed by the Department of Commerce. The plant of the wireless station consists of the following:

2 Bungalows (operators' residences).
1 Operating building.
1 Power house.
1 Mast, 243 feet high, complete with guys and anchors.
1 Mast, 75 feet high, complete with guys and anchors.
1 20-H. P., 2-cylinder Standard Gas Engine.
1 10-K. W., Northern Electric, single-phase A. C. generator.
1 3-K. W., Westinghouse, direct current generator.
1 2-K. W., Standard, motor-generator set, complete with automatic starter.
1 Storage battery, consisting of 40 cells chloride accumulators.
1 7-K. W., radio transmitting set, consisting of transformer, condenser, spark gap and spark gap motor, oscillation transformer, inductance coils, control switches, etc.
1 2-K. W., radio transmitting set, made up of units same as 7-K. W. set, only units are smaller.
1 Radio receiving set, complete.
1 Power panel in power house, complete with ammeters, voltmeters and all switches and apparatus for controlling power. Power indicating instruments and control switches located in operating building.

The telephone operator of the exchange has been in the service seven or eight years and receives a salary of $35 a month, and in addition a furnishd bungalow. The trouble-man receives a salary of $75 a month and furnished cottage. He has charge of eighty-four telephones and the telephones belonging to the company at Schofield Barracks. The equipment of the exchange is as follows:

One magneto switchboard of single-position type, equipped with thirty drops for local and trunking service. Two trunks to Waialua, and three to Waipahu connect this board with the Island telephone system.

The Laie exchange operators are paid $35 a month; trouble-man $80. The operators at this exchange are not furnished with cottages. The equipment consists of a single-position magneto type switchboard, thirty drops capacity. To these are connected the local lines of that district, as well as three copper trunk lines to Kaneohe switchboard, from which connection is made with Honolulu and the rest of the island. There is also one trunk line and from this board to Waialua, by way of Kahuku.

The equipment of the Waialua Exchange comprises a thirty-drop, single-position magneto switchboard, serving the local lines and also furnishing service to the rest of the island by means of five trunk lines to Waipahu, two trunk lines to Wahiawa, and one trunk to Laie by way of Kahuku.

Kaneohe Exchange is quite similar to the Waipahu Exchange, but serves a smaller number of subscribers. It is connected with the Automatic exchange at Honolulu by means of six metallic trunk lines, and its switchboard is equipped with a calling dial whereby any subscriber on the windward side of the island can instantly be connected with a party having an Automatic number in Honolulu. Three copper trunk lines connect with the magneto exchange at Laie.

The Kohala Telephone Company of Kohala was incorporated under the laws of the Hawaiian Government for the term of fifty years from June 1, 1887, by Robert Hind, James Renton, Henry P. Wood, J. Ralph Sneyd Kynnersley, Joseph P. Sissions and Edward G. Hitchcock, for the purpose of erecting and operating telephone and telegraph lines on the Island of Hawaii. It operates about one hundred telephones.

The Maui Telephone Company, county of Maui, has installed metallic circuit all over its system. There are in operation about 650 telephones, six public pay station telephones and twenty-four extension telephones. There are sixty-six party lines, the number of subscribers on which range from two to nine, and seventeen party lines with numbers ranging from nine to fourteen. In addition there are a number of extension telephones which have been purchased outright by the subscribers and for which they pay no rent. The company is negotiating with these subscribers to repurchase these instruments and charge them the current rate for extension telephones.

The plant lists as follows:

Poles, wires and construction	$37,000.00
Switchboard and equipment	2,500.00
Telephone instruments	7,500.00
Horse and wagons	1,305.00
Automobiles	500.00
Equipment and supplies	2,450.00
	$51,255.00

The Kauai Telephonic Company of Lihue, Kauai, was incorporated on October 2, 1880, but did not commence operations until the year 1890. The system is a partially grounded and partially metallic circuit; only two sections, however, are metallic—Lihue within a radius of two miles, and Waimea within a radius of one mile. There are 238 telephones in operation, including five public telephones, ten extension telephones and twenty extension bells. There are fifty-six party lines, and the number of subscribers on party lines range from two to eleven persons.

There are approximately 3,500 poles and 433 miles of wire in the system.

The descriptions of the switchboards are as follows:

1 (Lihue) No. 1200 B, Western Electric magneto, equipped with 60 drops, 15 pair plug; and testing cabinet.

1 (Waimea) No. 1200 A, Western Electric magneto, equipped with twenty-five drops, twelve pairs plugs.

St. Louis Employes all Volunteer

That every man in the Southwestern Bell Telephone Company, with headquarters in St. Louis, has volunteered for service in answer to inquiry of the company for volunteers to form a signal corps battalion for the regular army, is announced by General Manager F. O. Hale.

"Even the men who are beyond military age have besought the heads of their departments for the privilege of going, setting up that their physical condition is good and that their knowledge of telephone and telegraph work makes them desirable.

"We were expecting a hearty response, of course, to the circular issued to employes April 4, stating the objects of the signal corps, but what we received was a patriotic outburst of enthusiasm.

"Under arrangement with the government we are to create a signal corps battalion in the Southwestern Bell Telephone system, one platoon to be formed among the employes in St. Louis. We have enough volunteers in St. Louis for a regiment. They come from every department of telephone work.

"Of course, we expected that the plant and the engineering departments would furnish the greater portion of the quota, for signal service is right in their line and their technical training has been almost identical with army telephone field work. But I want to tell you that the commercial and traffic departments furnished as many volunteers.

"One branch of the accounting department, under General Auditor J. K. Wass, volunteered in its entirety within a half hour of the distribution of the pamphlets. If we accepted the offer of all the engineers that wanted to go we would not be able to furnish a blue-print in the conduct of our regular work."

Machine-Switching Telephone Gear

Abstract of an Address Before the Institution of Electrical Engineers, London, England

BY F. R. McBERTY

THREE limitations — time of switching, cost and number of machines—have determined the nature of mechanical line switches, and each has given rise to a series of inventions and developments. Of these the time-limit within which the switching operation must be completed has imposed the most rigid restrictions and has resulted in the most various and striking characteristics of switching mechanism. Because of physical conditions it has not been found feasible for commercial service to propel the movable terminal over more than about fifty or sixty terminals per second—a number which is not satisfactorily large. A number of inventors have solved the problem of driving a movable member over a sufficiently long row of fixed terminals by means of two motors of different speeds, the member being driven at high speed nearly to the desired point, say to the preceding decimal, by the first motor, after which it is connected with the low-speed motor which moves it at a rate suitable for accurate stopping to the particular terminal. By this means a straight row of terminals up to 500 can be covered within the available period.

A type of quick-acting switch better represented in the art is that having terminals in several rows in a compact rectangular field, the wanted terminal being reached in the field by choosing first the desired row and then the desired point in the row—commonly known as the "co-ordinate" switch. This form of switch is able to connect with the desired point in the field with a minimum of motion, and thus with the same speed permits a relatively massive construction. With such co-ordinate switches it is practicable to reach the most remote of 200 terminal points in one second.

The single row of terminals has been arranged in a straight line, in an arc, and in a complete circle. The motor elements required for producing the motion of movable terminals are correspondingly various; but development has favored two general types, of which one is the ratchet or "step-by-step" motor, and the other the power-driven motor, each with a different characteristic method of control.

With the demand for massive construction, high speeds, and large switch capacity, the limitations of ratchet motors have been found serious and recourse has been had to constantly driven motors to which the moving-switch member is clutched as required. The ratchet motor has the advantage of being quiet, except at the moments of propelling the switch member, which may amount to no more than one or two minutes per day. Aside from the presence of a constantly moving part, simplicity of construction and easy maintenance would seem to be in favor of the power-driven clutch. For such work as is required of a telephone switch is it a surprising fact that the annual cost of a piece of shafting maintained in constant motion is very little more than that of the same piece of metal still, and much less than the cost of maintaining a more complex form of motor device.

Size of Machines and Number of Multiples.—The machine for maximum economy in first cost must therefore represent a choice between a large number of terminals very inefficiently employed, with a minimum number of motors and movable members very efficiently employed, on the one hand, and on the other a small number of terminals efficiently employed and a large number of motor and moving members inefficiently employed. The subsequent cost of maintenance is of weight, since this cost is affected in a more important way by the multiplication of moving parts than it is by the multiplication of fixed parts.

The motion of the switching machine may be controlled primarily in either of two ways, for functions which may be described as "seeking" and "choosing" respectively. The switching functions are not essentially different; the moving terminal of a seeker or finder is driven to the required points and stopped there by the different condition of the point itself; whereas, in the choosing-switch or selector, the moving terminal is propelled through a measured distance which is controlled from a distant point; both functions are sometimes combined in the same switch. Nevertheless, the finders commonly require a smaller field of terminals for efficient operation than selectors, and each of the developed machine switching systems contains two forms of switching machine based on this difference of function.

Trunking Through Switches.—The manual switchboard is limited to about 10,000 lines within reach of the operator with a plug. The largest machine switch so far constructed is limited to about 500 lines within reach of the movable terminal. Recourse is therefore had to combinations of machine switches operating in series. It is unnecessary to emphasize the desirability of concentrating the traffic of the telephone system in the minimum number of machine switches; the extent to which it can be carried determines both the dimensions and number of the switching machines and thus the cost of the equipment. This concentration has been one of the main causes of the reduction in cost of machine-switching equipments to a point at which such systems can compete with manual-switching systems. In planning the switching equipment, the constructor, as well as the purchaser, must make a choice between first cost and quality of service.

For the inventor, the engineer and the purchaser of machine-switching equipments, the computation of the number of paths from calling to called lines, and the number of machines and trunk links necessary for producing the paths, becomes essential.

A subscriber calling, either gets through and speaks with his wanted subscriber, or he fails to get the wanted party; the result of failure will be definite loss of revenue for the owner of the equipment, coupled with dissatisfaction on the part of the users or a large increase in calling rate resulting from repeated futile calls. Each such repeated call may involve the use of the plant to almost the same extent as a successful and revenue-producing connection.

In the manual-switching system the calculation in advance of the elements for use in common has not been essential. In the planning of machine-switching equipments the accurate adjustment of the switching capacity to traffic in advance of construction is important. Discussion of relative merits of the several mathematical

methods of computing capacity is not within the scope of this paper; but some reference to the practical aspects of the current discussion of methods may be desirable.

It must be stated that telephone calls are not originated, or distributed among lines, purely by chance, but rather to some extent in accordance with fixed social and physical conditions; nevertheless a large number of calls originating under defined conditions can be treated as though they were initiated and distributed purely by chance through given periods of time and as originating and terminating at random in the different numerical or geographical groups of lines. Studies of chance are employed to determine the probable deviation from the

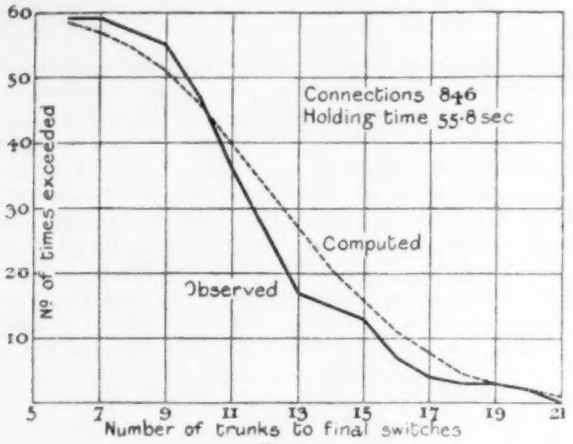


Fig. 1.

average. It is not expedient to provide for an absolute maximum of paths, but it is necessary to compute and make such provision that the switching capacity of any portion of the exchange probably shall not be exceeded more than a certain small number of times, which will appear negligible.

Illustrations are given of results computed by means of the theory of chance. These show a close correspondence between the computed and the observed results.

The correspondence between the number of switches required by traffic of given amount and character as observed and as computed from observed duration of conversation, is shown in Fig. 1. The observations were made in a semi-automatic machine-switching equipment known hereafter as "I." The total number of connections during the period of observation was 846, the average holding time per connection being 55.9 seconds. The selectors observed contained twenty-two trunks in a group; the twenty-second trunk was not required during the period of observation, though twenty-one trunks were required. As computed for one call lost in the period, twenty-two trunks might have been once exceeded. The correspondence between observed and computed results is noticeably close.

Practical Bearing of Computations of Probable Traffic.—Reference has been made in the foregoing to the percentage of calls lost or delayed by reason of deficient junctions or switching machines. The formulæ for computing chances permit the calculation of a switching capacity at the various trunk links and switching machines which will be adequate for all but a certain peak of load; this peak of originating load unprovided for will consist in calls delayed, or blocked, by a busy-back signal. The cost of accommodating the peak—particularly when the day's traffic curve shows sharp peaks—may be considerable. Fig. 2 shows the number of switching machines (and trunk lines) for two equipments otherwise identical, the capacity of one of which is such as to produce a delay or loss of 1 per cent of the day's originated calls in the switching equipment (excluding the loss at the called party's line), while the other gives the capacity which would produce about 0.1 per cent loss in the day's calls. The curves are figured on the assumption of four orders of switching machines, two busy hours per day (80 per cent of the peak traffic being taken as a busy hour), one-eighth of the day's calls in the busy hour, and a holding time of two minutes.

A system equipped in accordance with the lower of these curves would produce a number of "trunk-busy-tests" during the busy hour equal to about 4 per cent of the originated calls.

Controlling the Switches; Full Automatic and Semi-automatic Systems.—The manner of controlling the movements of the two types of switches with ratchet and power motors are characteristically different; the ratchet motor impulses of current are produced by the controlling means which operate the motor magnets of the switches successively step by step, advancing the moving member to an extent corresponding to the number of impulses; in the power-driven switch, the switch is set in motion and in its motion transmits back to the controlling means impulses of current which measure the progress of the switch and enable the controlling means to stop it when the desired displacement has been produced. The employment of the ratchet motor driven by a succession of current impulses involves a stoppage of the switch at each impulse and thus tends toward the reduction of mass to permit prompt stopping and starting. The second named type, which is known as the revertive impulse control, permits an uninterrupted motion of the switch parts and so permits the employment of relatively large masses, high speeds and extensive movements.

The standard form of controller for ratchet motors is a break wheel driven at a regulated speed which produces successive interruptions of current to the required number in the circuit containing the motor magnet. The revertive impulse type requires as a controlling device some form of magnet-driven apparatus which counts the impulses measuring the progress of the switch and breaks the circuit of the motor or clutch at the correct number.

The control of the switching machines may be exer-

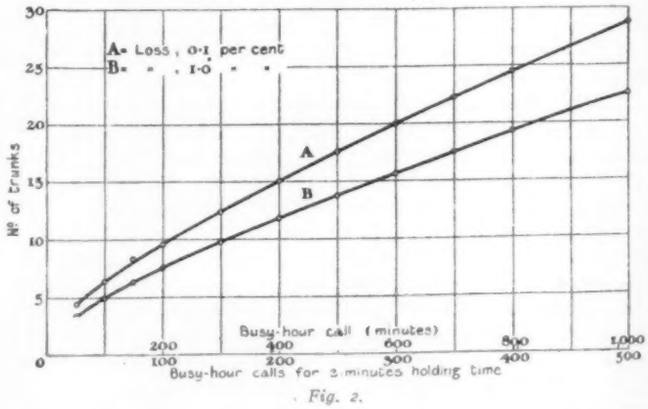


Fig. 2.

cised either by the subscriber himself, furnished with a number-transmitting dial or by an operator acting under the subscriber's direction by telephone. Some particulars are given of the control.

Call Distribution to Semi-automatic Operators.—The use of seeking machines, whether pre-selectors or finders, for concentrating the incoming calls upon the group-choosing switches, in semi-automatic operating, permits

at the same time a concentration of the work of answering, establishing and supervising connections upon a minimum number of operators and the equable distribution of the work among them. It is profitable to concentrate the incoming calls upon an operator up to her full capacity, which may be about 500 or 600 connections per hour. A condition limiting the load is the delay imposed upon the individual subscriber's call before it receives attention, which can be kept down only by reducing the load on the operator, and so increasing the wage cost per connection, or by distributing calls to a larger number of operators and thereby increasing the quantity of distributing machinery. The standard of promptness in answering a subscriber's call has already been fixed by experience with manual systems and cannot now be exceeded. This service is of the character in which averages are not particularly significant, but extremes determine the character of the service. The aim of good manual practice is to answer the calling subscriber in an average time of 3½ seconds, with no more than 5 per cent of the calls delayed more than ten seconds.

Fairly close correspondence is found between observed results and chance plays, and the latter method is therefore valuable for determining the effects of call distribution. Fig. 3 illustrates the correspondence between chance plays and the results observed, for example, in the manual switchboard "M" when the operators were specially loaded to 300 calls each in the busy hour, with team work among three operators. The operator's delay in answering a call in a manual switchboard is composed of two factors, of which the first is a nearly fixed minimum time of rather more than two seconds for observing the call signals, plugging into the calling line and connecting her telephone; while the other is the wait imposed while the operator serves other calls, which increases with increasing load. The inclination of the curve of observations therefore tends to the horizontal towards the left. In the case of the curve of chance plays the constant factor for physical work is not present.

Fig. 4 was plotted from a large number of similar chance plays, for an assumed handling time of five seconds per call. It shows the relation between subscribers' waiting time and different loads per hour per operator for a team of three operators to whom the calls originating by chance are distributed as equably as possible, the mechanism being assumed to pass the call to the operator's telephone as soon as it is free. The charts indicate that a high grade of service can be attained consistently with a high load upon each operator, by providing for connecting any call originating among two or three thousand lines with any of six or more operators. To perform such a distribution requires seeking switches of large switching capacity.

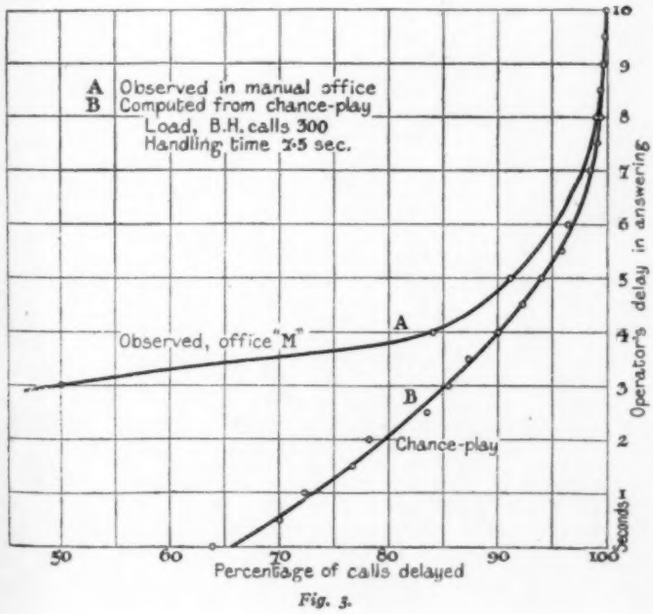


Fig. 3.

In a semi-automatic installation in France, in order

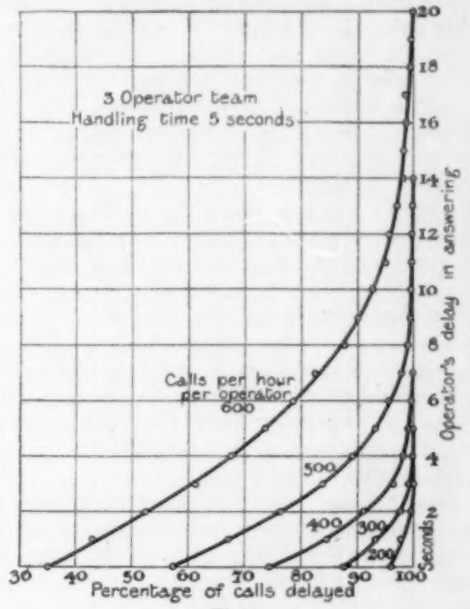


Fig. 4.

that the excess calls passed to positions may not be delayed unduly or kept waiting before an operator engaged on a troublesome call, two special features are employed known as "timed distribution" and "helping out" respectively. The "timed distribution" consists in maintaining the busy test of the operator's position for a measured time after the passing of each call to her telephone, and increasing this measured time progressively for second and third calls passed to the position in quick succession. When a call is passed to an operator's position the position is made busy for three seconds, which period—together with the time required by the mechanism itself to seize and pass to the telephone another call—cover the average handling time for the call. After the arrival of a first call, therefore, immediately succeeding calls must pass to other positions. During normal loads some position usually will be idle to take the call. A call arriving while all positions are busy will be taken by a finder of some position, but in such a case the timing device will maintain the busy condition for five seconds instead of three; for that period directing other excess calls to other positions. Provision is made for the arrival of a third order of calls, though such calls are highly improbable. The busy periods can be adjusted.

The office in question is the center of an important toll traffic which is provided for in the usual manual toll and recording positions. The switching of calls from lines demanding toll connections and of calls for lines of the automatic equipment are performed by machine switches. A call originating for a toll line is disposed of by the operator by pressing a special toll key which directs the call at the first group selector into a group of trunks leading to a recording position, where the recording operator notes the numbers of the called and of the calling

parties; or by the operation of the dial by the full automatic subscriber, which sets the register at a special position and so directs the call to the same group of trunks to recording operators. Provision is made for the automatic prevention of metering calls to the recording operator.

Traffic between Manual and Machine-switching Systems.—The particular exchange equipment described is in the single large office of the area; conversion of the area to automatic working takes place completely with the cutting over of the office. When the machine switching equipment is in one office of a multi-office area, special provision is required for passing calls from the manual to the automatic equipment and from the automatic to manual equipments, without impairing the telephonic service or reducing the efficiency of operation of the automatic equipment.

For receiving traffic from the manual office lines in a machine-switching equipment, semi-automatic positions are furnished in which the junctions terminate from the manual office. These junctions may, as desired, be on the ring-down or the order-wire basis.

The service at the incoming semi-automatic terminal of the junction is surprisingly accurate and prompt; the calls are disposed of with such swiftness as to reduce the drag of the "B" operator upon the "A" operator while permitting the carrying of a substantially increased load by the "B" operator.

Passing traffic from a machine-switching office (whether semi-automatic or full-automatic) to a manual office is performed with the aid of a number indicating device before the incoming junction operator in the manual office, which reproduces before the operator visually the number stored in the registers by the semi-automatic operator or by the subscriber.

Telephone Service in Machine-Switching Systems.—The benefits derivable from the substitution of machines for operators and manual-switching apparatus are of three principal sorts: improvements in service, economies and freedom in development.

The promptness of switching in the full automatic system leaves little to be desired by the user. The ringing of the bell at the wanted station begins practically as soon as the calling party completes dialling the number. In systems with operators, the delay which ordinarily impresses the subscribers is that in reaching the operator to give his number; and the quality of service is judged by the percentage of occasional long delays, as well as by the average time of response. The standard for service in manual exchanges generally accepted has already been referred to—the average response for the number is 3.5 seconds after the subscriber takes the telephone with no more than 5 per cent delays exceeding 10 seconds.

Table I shows the times for answers measured from taking the telephone (or calling) to the answering operator's response:

TABLE I.—ANSWERING TIMES, AVERAGE

	Seconds.
Manual central battery, standard	3.5
Manual central battery, heavy load, "M"	4.5
Semi-automatic system, "I"	2.1
Semi-automatic system, "J"	2.2

Another measure is the time from initiating the call to the beginning of ringing the bell at the wanted station. Within this period there is no delay which is not directly dependent upon the operator and the apparatus except the drag of the subscriber in giving his order, which ordinarily is not a large factor.

TIME FOR INITIATING CALL TO RINGING BELL OF CALLED STATION

	Seconds (av.)
Manual C. B. exchange, "M," best performance	10.3
Manual C. B. exchange, "M," heavy load	12.0
Manual C. B. 100 per cent junction calls	18.5
Semi-automatic, "I"	10.3
Semi-automatic, "J"	10.5
Full automatic, "H"	8.5

Data for direct comparison of the time of connecting for the same subscriber's lines by manual and by machine switches is at hand for only one office, I, located in France. The replaced equipment was a magneto board; the replacing equipment a Western Electric semi-automatic machine system. The measured times run from the moment of the operator's answer—the insertion of the plug in the one case, the passing of the call to the telephone in the other—to the beginning of ringing. This data is presented in Fig. 5 in the form of two curves, showing the times required for completing different percentages of connections. In the machine equipment the average time is about half that formerly experienced, and 95 per cent of the connections are made in one-fourth the former time, the maximum time being only one-fifth of the former maximum.

The shorter time noted in the above table for the full automatic system is due to the omission of the time of waiting for the operator. Otherwise the time for getting connection in a self-contained office is not largely different in manual and in machine-switching systems. In multi-office areas, however, with a considerable percentage of junction calls, working through second operators adds largely to the time occupied in manual switching, but adds nothing to that in machine switching.

A third improvement in service of marked value, but obscure origin, is that before referred to as an increase in the availability of the subscriber's lines. The duration of a connection is noticeably less in machine-switching systems, as seen in Table II.

TABLE II.—DURATION OF CONNECTION

	Seconds.
Manual magneto, accepted average	180
Manual magneto, office "I"	175
Manual C. B., accepted average	120
Full automatic, Strowger	83
Full automatic, "H"	112
Semi-automatic, "I" calling line	102
Semi-automatic, "I" called line	97
Semi-automatic, "J"	60

It is notable that at office I where accurate observations were made of duration before and after installation, the change brought the holding time down from 175 seconds to 102 seconds—or, if the occupied times of the pair of lines be taken, from a total of 332 seconds to 199 seconds, a reduction amounting to 40 per cent, and resulting in more than a proportional increase in the availability of the line and decrease in the percentage of busy calls.

The more obvious economies offered by machine switching are in operating and supervising forces and in plant. The possible net savings in operating are still subjects of controversy, while the savings in plant which might be made are still somewhat speculative.

The handling time of the operator per connection is a very significant though not an entirely satisfactory measure of probable operator's loads and costs of operating, for the reason that it is definitely measurable and comparable in different systems. The busy-hour load is, however, fairly indicated by dividing the seconds per hour by the average seconds of handling time per call; the discrepancies produced by that process are not so great in the case of semi-automatic as in manual switching. The

two main influences which restrict the raising of loads in manual working—the increasing delay to the subscriber and the fatigue of the operator—are greatly reduced in automatic working.

The fatigue of the operator is very noticeably less in machine-switching systems. Accepted manual practice has favored keeping an operator occupied about 60 per cent of the hour, with occasional short periods of 75 per cent. With such loads the operator is physically and mentally busy. In semi-mechanical operating, an operator may be kept occupied normally 75 per cent or 80 per cent of the hour, with higher percentages on occasion, and with such loads is working easily.

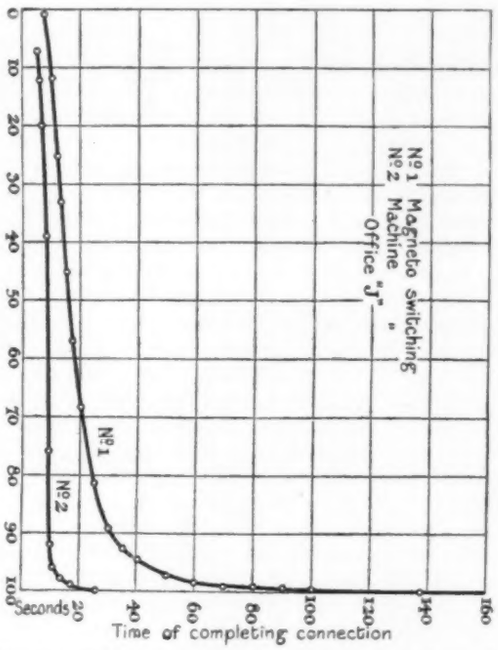


Fig. 5.—Time for Making Connection Expressed in Percentages of Connections in Different Periods.

An operator at a manual central-battery board with no trunking can give fairly prompt service without undue fatigue under a load of 230 calls per busy hour, and can carry a load of 400 calls with exceptional fatigue and a notable impairment of service. Such an operator can give more prompt service with ease through a mechanical switching system system under a load of 450 or more busy hour calls of like average character and can carry 600 or even 700 calls in exceptional cases without noticeable impairment of service or troublesome fatigue. Junction calls reduce the load materially in manual systems, but not at all in mechanical switching.

Maintenance of Machine Switches.—As in the earlier history of the conversion of central office equipment from the magneto to the central-battery system, so in the conversion of central battery to machine-switching systems, the difficulties and expenditures actually experienced turn out to be less important than anticipated, and show a substantial diminution as the result of progressive improvement in manufacture and in practice. The early automatic exchanges required the attention of men in such numbers and of such skill to keep the equipments in good working order that their wages largely or quite counterbalanced the savings in operators. Experience with modern equipments demonstrates that the maintenance force need be hardly more numerous or more skillful than that required for manual equipments of equal size; while the faults requiring maintenance are of such a nature as to warrant the expectation of still further reductions in staff.

The expenditure in wages constitutes the main item of maintenance expenditure; those for materials and replacing parts are practically negligible.

The labor of maintaining certain typical automatic exchanges is shown in Table III, expressed in man-hours per line per year. These examples have been selected as typical from among a considerable number because of the fairly accurate and complete data available with respect to them.

The year is estimated at 313 days to bring all examples to equality with certain equipments in which there is no maintenance on Sunday—excepting in the case of office H, calculated for 12 months from data of one month. The number of lines given is that of lines actually in operation. In all cases, except offices G, H and I, the numbers of man-hours covers the time of maintaining the switches only, excluding time spent on power plant, distributing frames and manual switchboards. The times given for exchanges G and I include the maintenance of the power plant and manual portions of the equipment, while that given for office H includes the work on manual toll switchboards but not on power plants.

The errors noted for exchanges A, C, D, E and G were observed by standard service tests from sub-stations; those for offices H, I, J and K were observed by tests and observation at the main distributing frame. Offices A to F inclusive are ratchet-driven equipments, while offices G to K inclusive are power-driven. Offices A, B, C, G and K were operated by telephone companies, while offices D, E, F, H, I and J are operated by postal administrations.

In offices of relatively small size the amount and cost of labor is largely affected by the need or preference for continuous attendance. Offices A to F, and K, are attended continuously through 24 hours, offices A, B, C and K by men in three shifts, offices D, E and F by men in two shifts. Office G was operated for 12 hours per day only, with continuous attendance during that time; office I operates and is attended from 7 a. m. to 12 p. m.; office H operates through the 24-hour period, attended only from 8 a. m to 5 p. m., with no attendance on Sundays; office J operates throughout 24 hours with attendance during 12 hours.

A special study was made at office G to determine the effect of reducing the hours of attendance. For a period of 11 days, during which 83,000 connections were recorded, all maintenance of the equipment was withheld, with the single exception of removing a fuse from one switch to put it out of operation. The equipment gave satisfactory service throughout the period. For an equal number of connections just prior to the test the percentage of errors (failures to obtain proper connections) was 0.27 per cent; at the end of the test the percentage of error had risen to 0.57 per cent. In a later test the maintenance and repair of the equipment was suspended for a period of six weeks; attention was confined to recording the errors and removing the fuses from switches marked as frequently producing errors. During this test the percentage of error did not change substantially, but at the end of the period of six weeks 12 per cent of the selectors had been temporarily withdrawn from operation for cleaning or repair. The switching service was satisfactory throughout.

These instances indicate that with apparatus of good construction the quantity of labor can be largely reduced by withdrawing attendance during slack hours, nights and Sundays.

A minimum attendance probably can be reached by employing one man in a single shift of eight hours during the busy portion of the day. For a 1,000-line exchange this would result in 2.5 man-hours per line per year.

An element which is important in estimating depreciation as a factor in studies of annual charge is the probability of displacement by improved apparatus. This is always a difficult factor to evaluate, but in the present

TABLE III.—MAINTENANCE LABOR.

Exchange	A	B	C	D	E	F	G	H	I	J	K
In service	1905	1910	1910	1910	1911	1912	1909	1914	1915	1915	1915
Type	Full	Full	Full	Full	Full	Semi	Semi	Full	Semi	Semi	Semi
Lines	13,500	2,000	5,000	750	2,300	3,150	450	700	960	780	6,500
Call-rate	..	4.5	4.5	3	10	12	22	..	2	10	3
Error per cent.	5.4	..	5.0	17	5.3	..	0.25	..	..	0.01	0.37
Man-hours per line per year	6.7	6.3	3.2	12.6	11.5	5.4	6.9	6.1	5.5	2	5.2

Studies made in exchanges G to K indicate that the time of the attendant would be occupied to only a very small extent in inspecting, testing and repairing the switching machines.

A tabulated analysis of faults reported, identified and corrected is given.

In exchanges H, I and J no failure has been observed of contact between the bronze collector springs and commutator rings, leaf springs and brushes, or brushes and terminals. The line terminals and brushes require no cleaning or attention. The woven ribbon cable for the multiple connection at the rear of the arcs in the exchanges collectively has required 12 repairs, the cases being broken wires and loose bits of solder. The driving power has caused practically no trouble. The total value of parts replaced in all these exchanges is well within £5 ($25).

The difficulty of obtaining men of sufficient skill and training for maintaining an automatic equipment often has been unduly emphasized. The exchanges A to C, G and K have been maintained in the main by men trained in the factories and in the installation of the equipment; those in charge of exchanges F, H, I and J, and in certain others of a like character, have been taken from the administration's forces ordinarily employed in the maintenance of manual central-battery equipments, selected with somewhat more care than usual, and with a certain amount of instruction and experience during the periods of installation and initial operation of the plants under the supervision of the installing engineer.

The foregoing studies distinctly indicate that a machine-switching equipment of either of the available types, of modern construction and of moderate or large size, can be kept in good operating condition with an expenditure of labor not exceeding 5 or 6 man-hours per line per year, and that the expectation may be entertained of reducing the labor in fairly large equipments to one-half that amount or less.

Depreciation of Machine-Switching Apparatus.—The actual depreciation—wear, breakage and deterioration—in a machine-switching equipment is not heavy, and eventually may be found to be less even for the present types than the rate of depreciation commonly assumed for manual equipments. The customary rate of depreciation would naturally be applied for the sorts of apparatus well known in manual practice. As to the switching machinery, sufficient experience has accrued to warrant the expectation of a rate of actual deterioration in no case greater but possibly less.

Although exact comparative data are not available, it would appear that the repairs in machine-switching systems will be fewer and less expensive than the repairs to cords alone in manual equipments.

In view of these facts, it is the opinion of the author that an actual rate of deterioration for a machine-switching equipment may be assumed conservatively to be equal to that of a manual central-battery equipment.

circumstances a partisan of machine switching might find warrant for assigning to it a larger value for manual than for automatic switches.

Pennsylvania Independents Prepare

Loyal support to the Federal Government in the war with Germany was pledged by representatives of Independent organizations in convention April 14 at Philadelphia. With a rising vote, the telephone men adopted a resolution to stand by President Wilson, after they had listened to an address by Captain W. S. Grant, of the United States Signal Corps.

The resolution follows: "Resolved, by the representatives of the Independent telephone companies of Pennsylvania, assembled in Philadelphia, the cradle of American independence, that their co-operation is hereby pledged to the President of the United States in his task of carrying to a successful conclusion the war which the country has felt obligated to participate in, and that the chairman of this convention be instructed to transmit this resoluion to the President at Washington."

Captain Grant, who spoke at the luncheon which closed the convention, explained the telegraph, telephone and radio systems of the modern army, and asked where if not from telephone and telegraph companies the Government could procure experts to fight successfully on a big scale. He declared that great progress had been made in organizing telegraph battalions but that much remained to be done. When Captain Grant finished his address, the members of the telephone companies, one after another, rose and pledged the support of their organizations.

James Collins Jones, vice-president of the Keystone Telephone Company, who presided, declared:

"It will be the pride of the Independent companies to show that we are ready and anxious to serve the nation and that we await the word of command."

F. B. MacKinnon, vice-president of the association, who represents the Independent companies on the Committee on Communications of the Council for National Defense, brought the telephone men to their feet by observing:

"This is a great opportunity to show the people we are public service corporations, indeed." Mr. MacKinnon added that it was up to the companiles not only to maintain their present general service at a standard of high efficiency but to carry on the work required of it by the Federal Government with signal ability and fidelity.

Crack Signal Corps

Perhaps the finest auxiliary signal corps possessed by any army has been given to the United States by the American Telephone & Telegraph Company. About 500 engineers already have been selected and some of them have been sworn into army service. The differences between government pay and their salaries with the telephone company will be paid by the latter.

Preparedness

The Independent Telephone Companies Will Do Their Part

BY TERRY W. ALLEN

THIS country is at war, but on the surface there is very little disturbance. Things are going on as usual, and while in certain localities there are appearances of military activities, in general there is the calm that is usually experienced before a storm.

Last month I was in Washington and New York. I was surprised at the calmness with which those two large centers were taking the situation. In Washington and New York both there was little or no evidences of the fact that the country was at war and that there was a large undertaking before the government of the United States. Yet even with this condition existing, even with this lack of outward display of military activity, there was underneath this calmness a determination that I found in practically every place I visited to see this thing through, and a general support of the president and his policies.

There can be no question that preparedness became essential when we entered into the overseas campaign in the war that has been disturbing Europe for the past three years. Our preparedness will have us ready for any eventuality that may occur, and it is this form of preparedness that strikes me as being most essential. It is this form of preparedness that I would like to see incorporated in the course to be pursued by the Independent telephone industry, both manufacturing and operating, in the country generally—the form of preparedness that, in case anything does happen that tends to jeopardize the investments in Independent telephony would find us ready; prepared to defend our rights—prepared to take care of ourselves, no matter what problem had to be met.

There is no question to my mind about the important part that the telephone companies of this country are going to play in this war that we are preparing for. Even the small farmer's line, isolated though it may seem to be, may be of the utmost use in helping to keep the country informed of the conditions existing and to disseminate information that may be essential to the best interest of this country. In this regard there should be a certain form of co-operation between all telephone companies, and only under the present conditions existing should we think of such co-operation. But it is a question now of government ownership and control, temporarily, of telephone companies, or it is lending our best efforts to serve the government competently, intelligently and efficiently to keep them from taking over the telephone companies of the country and putting them under the domination of the Federal Government. Once the talons of government ownership are embedded in the tender flesh of the telephone industry of this country, both Bell and Independent, it will be hard to shake loose the grip that will be fastened upon us. It is for this reason that I deem it essential that all telephone interests, both Bell and Independent, should bury their differences temporarily and lend all of their power toward helping the government in every way possible, so as to keep the government from confiscating the telephone systems of the country and putting them under the government's control.

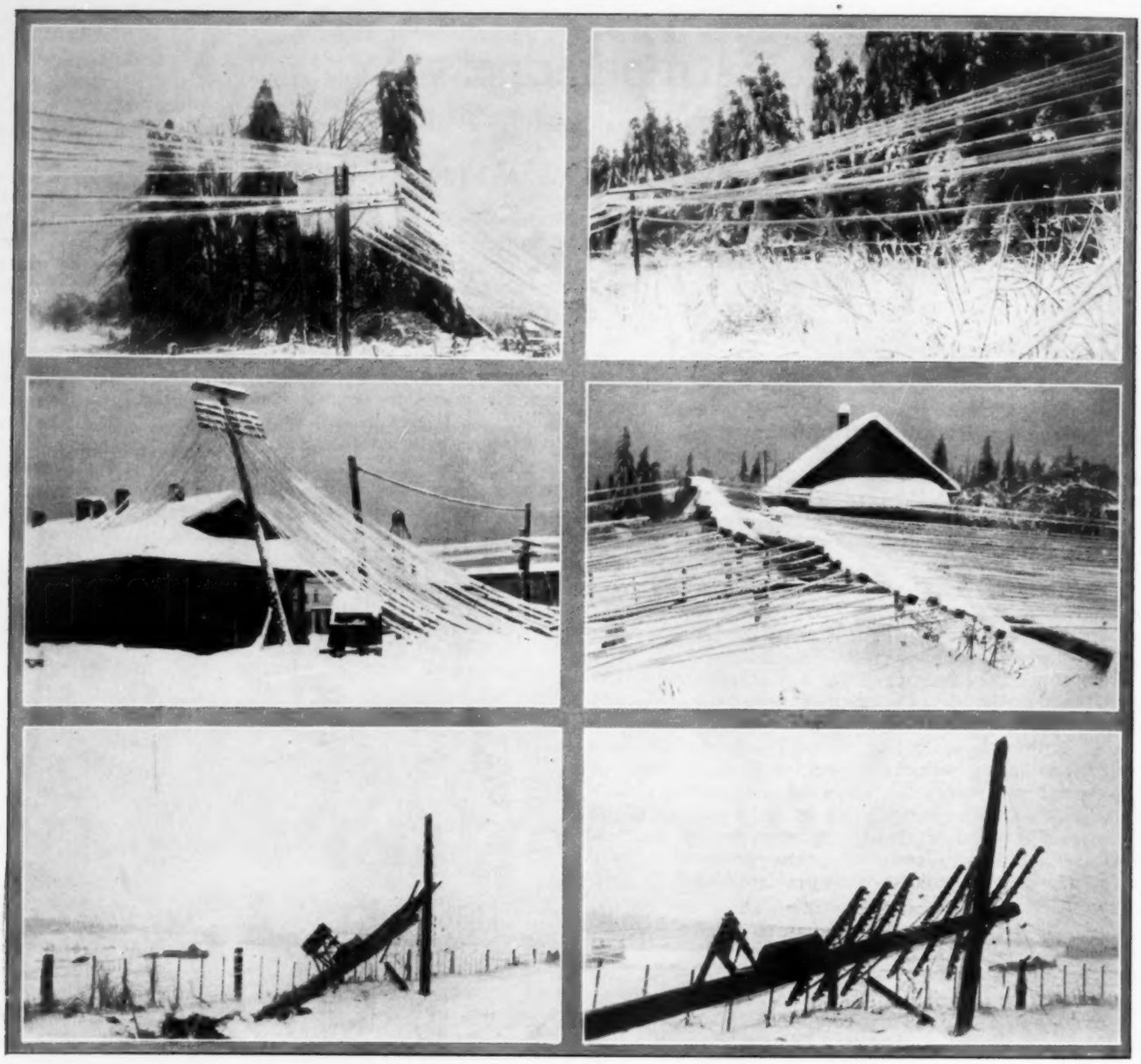
The Bell Company should realize that its merger program, the violation of its word to the attorney-general, and all activities along this line should be temporarily abandoned in good faith (and I mean that phrase, good faith, for heretofore there has been anything but good faith in the Bell Company's activity); and in this connection I should say that for the Bell Company to try to put through these mergers will only hasten the support of honest Independent telephone operators to the side of government ownership and control. Consequently, if the Bell Company would aid and help in this war time, if it honestly wants to serve its country to the best of its ability, as it says it does, it should by all means call a conference between the Bell interests, the Independent interests and the government; and it should make promises in writing to the effect that during the eventualities through which we are now passing, for the best interest of all concerned differences of all kinds should be laid aside and an honest effort made to give the country that service to which, in this event of war, it is entitled. I really do not expect to see this attitude on the part of the Bell Company, but it is the right attitude. Government ownership is fearfully near, if once the government takes over the telephone lines of the country. Possibly government ownership may be a good thing, but I have never been able to see why we should have it unless in the face of unfair competitive methods. We need right now patriotic men and women in the telephone industry. The country needs every patriotic citizen to respond in some way to help in carrying on the war. Consequently, no stone should be left unturned to give that service to the government. Independent telephony will do its part.

Mobilize Operators for War

To meet a possible emergency arising out of further developments in the war between this country and Germany, the Chesapeake and Potomac Telephone Company will mobolize at Washington, D. C., a number of highly trained special long-distance operators for work over the lines out of Washington. These operators will be retained while the emergency lasts, and as soon as conditions justify will be returned to their home stations.

W. E. McMahon, traffic superintendent of the company, said that the plan was only for the grave emergencies of war, and not a permanent policy. He said that while there are 80 long-distance operators drawn from local sources employed at present, it was possible that eight or ten would be needed in addition.

These, he explained, were required to be highly trained. As it would take time to train more local employes, the company planned to bring the extras for temporary duty, so as to have an emergency force ready at any moment. The extras will be imported from New York and Philadelphia principally. Their rate of pay will be no more than is paid others in their grade. They will, however, be lodged and boarded by the company, as it is possible that the operators will be required to work for twenty-four hours at a time. The point was emphasized that there is no intention to overlook local employes and that only in an emergency are such measures contemplated.



The Joint Use of Poles

Report of the N. E. L. A. Joint Pole Committee at Los Angeles

BY SECRETARY J. E. McDONALD

THE function of a joint pole agreement is to provide a method whereby the number of poles occupying streets, highways, and other public places may be reduced to a minimum. With no other obligation than "to play the game on the square," the Los Angeles public service corporations have been operating under such an agreement for over ten years, during which time approximately 80,000 poles have been involved by its terms and conditions. The collaborators only knew the results which it was desired to accomplish by the agreement and "intent and purpose," rather than "ways and means," constitute its dominating features. It was the intent and purpose to eliminate all superfluous poles as soon as practicable, yet there was no suggestion in the agreement that joint construction should be obligatory in any case. To make joint construction mandatory by agreement, would in effect be same as self-imposed ordinance requiring the reconstruction of overhead lines regardless of the merits of each case. Briefly stated, an agreement should set forth and formulate general rules governing equitable adjustments for all cases of construction and reconstruction which are likely to arise in practice. The administration of the agreement, manner of making repairs, renewals, reconstruction, or changes in location of joint poles, limitation of attachments, maintenance of wires and cables, termination of joint ownership, salvage, rights of way, taxation, and liability are all important items which should be fully covered to conform to the requirements of local conditions. A general specification covering joint construction methods is desirable. Such specification

must not conflict with any legal requirements of state or municipal authorities.

Application of Agreement—Various methods may be adopted for making the agreement effective. Matters involving joint poles may be handled through routine channels by regular employes of the utilities affected. Where a large territory is to be covered and where there are several utilities involved, a better method is to appoint a committee, consisting of one representative from each utility. This committee should elect a secretary, who may be one of its own members and act without salary, or if the project be sufficiently large, he may be an independent employe not otherwise affiliated with any of the utilities. The duties of a committee include all preliminary arrangements for joint construction and the preparation of records in connection therewith. Any utility desiring to make a change in its pole plant, notifies the committee of its intentions so to do. The committee proceeds to find out if any other utility is affected and desires to be provided for, making the necessary plans and arrangements accordingly.

Charges for Joint Use.—The joint use of poles involves the buying, selling, leasing or renting of pole facilities. Charges for joint use are usually based on the valuation of the pole, set, painted and stepped, ready for installation of crossarms, wires, cables and other appurtenances. These charges may be made on the basis of joint ownership, joint use under perpetual easement, life rental, annual rental, or contact rental. As standardization is desirable, it is inadvisable to permit of an indiscriminate choice of method under one agreement. The joint ownership basis is a very effective method, which provides for the sale or purchase of an undivided share or interest in poles. This method has the slight disadvantage of requiring great detail in making appraisals for rate making or taxation purposes. Joint use either by perpetual easement or life rental is free from this advantage, and if rates are developed to include the proper proportion of the fixed charges, either method may obviate the necessity for much inter-company billing, such as exists under the joint ownership method. On the other hand, it is impossible to make these charges absolutely equitable. A rate which is effective for two companies is excessive on the advent of a third party, and it seems impracticable to provide for refunding on rentals owing to the endless detail which this would involve. Charges on the annual basis are open to the same objections and in addition involve an annual check which is expensive where more than two companies are concerned. A contact rental is not applicable to a general joint pole scheme, but furnishes a convenient method for a limited number of contacts in special cases. These rates should be sufficiently high to discourage their general use. All conditions considered, the joint ownership basis represents the most effective method. With the proper unit record of poles the objections to this method are negligible.

Records.—Common practice in recording joint poles comprises the preparation of a map and schedule supplementing the working agreement. Each of these supplements in itself is a contract and is executed by the parties interested. Continuous use of this system has developed its weak points and it is no longer recommended where more than two utilities are operating. It is believed that a pole is just as important a part of the plant as a meter, transformer, telephone or other piece of equipment. As such it should be considered as a unit. Each pole—joint or otherwise—should be numbered and initialled, the initial signifying original ownership. All reference to any pole should include its number and initial. Each utility should have its own complete series of numbers. In the event that it is necessary to handle recording work through a regularly organized committee, the following method has been found fairly adequate. Applications for joint use are made by the pole number on regular forms provided for the purpose. If one or more of the poles applied for is already a joint pole, the previous record discloses this fact and the committee makes the segregation, referring the application to the proper parties. If the pole or poles are not of record, copies of the application are forwarded to the owning party, which furnishes complete recording data in approving the application. This eliminates the necessity for a field check on the part of the committee. Authorization for billing is covered by a bill of sale. These are issued monthly in accordance with applications which have been duly approved for the various interests involved. A card index for each pole is prepared, two copies of which are furnished each party to the transaction. One set of the cards is for consecutive file and the other is for filing according to location. The information necessary for recording is as follows: Pole Number, Location, Length, Year Set (New or Second-hand), Conditions (as to Painting, Stepping, or Treating), and the joint users, with their equities and circuits. Each card contains this information together with reference to bill of sale; the basis of settlement, and the application number of the utility purchasing interest. The cards are prepared and multigraphed prior to the preparation of the bill of sale and forwarded to the interested parties for checking. Cards for subsequent transactions involving the same pole, show all preceding transactions and constitute a true and complete record. Under the unit system, billing is authorized in all cases within thirty days.

Under the supplement method of recording, it is difficult to maintain a true record at all times owing to the continual changes which are taking place in ownership and replacements, which are being made from time to time. Further, the time taken to obtain the signatures of all parties to the combination is excessive. As individual replacements take place, the record is continually approximating the unit system and it therefore seems desirable to adopt this system in the initial stages of joint construction. If it ever becomes necessary to change systems the task may be extremely onerous. When it was decided to adopt the unit system in Los Angeles there existed 14,511 supplements, which are being worked over to conform to the more modern system.

Expense.—The cost of recording must necessarily depend upon the volume of transactions. Based on average monthly transactions involving 300 poles, the cost of recording may amount to $1.25 per pole, and may not justify the existence of a committee. For average monthly transactions involving 2,000 poles, the recording cost by committee should not exceed 50c per pole. In Los Angeles, the expense is pro-rated against member companies. Utilities which are not parties to the general agreement are frequently permitted to participate in joint construction and are charged 15 per cent of their equity in combinations recorded. The amount so collected is deducted from the total expense of the committee before pro-rating.

This method is not essentially correct. It has been proposed that the utilities be divided in two classes—members and non-members, or members and associate members. Member companies should be assessed a fixed monthly sum and associate members should be charged a percentage of their equities in combinations recorded as heretofore. Any expense in excess of the sum derived from the fixed monthly assessments and the collections from associate members should be prorated against member companies in proportion to the monthly transactions involving these companies.

Results—There are certain intangible benefits to be derived from joint construction which cannot be estimated. In 1908, the property owners on a certain street got together and demanded underground subways for all public utilities. The municipal authorities were favorable to the project and an ordinance creating the underground district was prepared. The committee became active and obtained an agreement with a majority of the property owners, agreeing to the maintenance of one joint line on each side of the street for a period of at least five years, provided that joint construction was immediately undertaken. The proposed underground covered a distance of 9,300 feet and involved five utilities. It was possible to accomplish the reconstruction without setting any new poles, and over 300 superfluous poles were removed from this section. The property owners were so well satisfied that the underground project has been entirely forgotten, although almost nine years have passed since the signing of the agreement and part of the street is in the remote business district where underground may again become an issue at any time. A more significant result is found in the direct economics effected when two, three or four utilities occupy the same pole, dividing the investment cost and also fixed charges which amount to at least 19 per cent of the pole value annually. Another important benefit arises through the legal requirement for overhead construction, which makes it extremely difficult to comply with such regulations except through a joint use of poles. Taken, therefore, as an operating condition, the joint pole should be considered as an economic necessity rather than a choice of the lesser of two evils; an involuntary choice sometimes between overhead and underground construction.

Special Problems.—A large part of all combinations are affected on existing poles. Such combinations are made in routine manner and present no unusual conditions for consideration. A small percentage presents no greater problem than the preparation of plans for the approval of the utilities affected, where it is proposed to make extensions into undeveloped territory, or to reconstruct an account of public improvements (the opening and widening of streets and changing of grades), or to reconstruct on joint poles to offset the demand for underground conduit and subways where assurance can be given that a joint pole line will be acceptable for a reasonable term of years. A small percentage involves special problems in equity, which can only be adjudicated in conference and compromise by the utilities concerned. These involve locations occupied by two or more utilities where reconstruction becomes imperative for one of them but not for the others. The existing construction of one or more of the utilities occupying this location may be entirely edequate and in first-class shape, or it may be partially or almost wholly obsolete. Certain general rules may be formulated governing such conditions, but no rule will fit all conditions which are likely to arise in practice. In general, the party through whose necessities reconstruction becomes necessary, should not be instrumental in making the conditions any more objectionable after reconstruction than before. If a joint lead of recent construction is overbuilt, it is incumbent upon the constructing party to make whatever concessions are necessary to continue the highly improved condition. On the other hand, if overbuilding the leads of one or more parties whose poles, wires, and fixtures are apparently inadequate and obsolete, the constructing party should not be called upon to make any concessions other than to set poles sufficient for the joint use of all parties occupying this location and such parties should purchase interest or easement in the usual manner. Between these extremes there are many conditions requiring special consideration. Mutuality of interest will bring about a solution in nearly every case. It is only during a period of general retrenchment that these conditions are not likely to obtain.

Suggested Developments.—In line with the development of the joint use of poles it is apparent that the possibility exists for further co-operative effort. The time is not far distant when over half of all poles will be occupied jointly. With the present day tendency toward concentration it would be a desirable undertaking for the pole using utilities to have their entire pole record centralized. This possibility was given consideration when the unit system was adopted and pole report forms are in use for joint poles which, if adopted universally, would bring about the result proposed without any abnormal demands upon the operating companies. If it is desirable at all times to have a correct valuation of the pole plant, such a method offers an easy solution.

Mayor Demands Physical Connection

Physical connections between the two telephone companies now operating in Grand Forks, N. D., are recommended by Mayor James A. Dinnie in his message delivered at the annual meeting of the city council.

The mayor declares that the double system doubles expense and causes inconvenience to the users of the service, and recommends the appointment of a committee consisting of three members of the council and two private citizens to investigate the matter and take whatever action may appear necessary. The mayor's message says:

Much complaint has been made concerning the telephone service in this city; the rates charged are claimed to be excessive and the service rendered, inadequate.

There are two telephone systems in the city and there is no physical connection between them, thus doubling expense and creating much unnecessary annoyance and inconvenience.

I do not know of any higher service that could be rendered by this administration than to take steps which might alleviate or remedy these conditions and relieve the people from this unnecessary expense.

It is asserted that the franchise of one of the telephone companies has expired and it is unquestionable that such franchise was improvidently granted and very inadequately protects the interests and rights of the people.

I recommend that the question here touched upon be referred to a committee consisting of three members of this council together with two citizens and tax payers of the city who shall be vested with all possible power and authority to make a full and complete investigation with a report of the facts and recommendations to your body upon which action may be taken.

Telephone Vibrations Direct Aircraft

Ingenious Device Uses Sound Instead of Radio for Distant Control

AN Australian inventor has developed a new method of distant control, which is, he considers, a great improvement on the wireless method, since it may be so arranged as to absolutely prevent interference by "unauthorized persons." A demonstration of the device was recently given in London.

The natural interpretation of the term "unauthorized persons" under present conditions is, of course, "enemies." Before proceeding to indicate the nature of this invention it may be well to point out that distant control of aircraft is only one out of a great numbe of applications of which the instrument is capable. In fact, using it for this particular purpose is, perhaps, in the inventor's mind merely a minor "side line," fraught with posibilities as it would appear to be.

Briefly speaking, the inventor makes use, in his device, of the well-known principle of resonance, which will be familiar to most of our readers. Those not already acquainted with it may demonstrate it by the very simple experiment of pressing down the "loud" pedal of a piano and playing a note on some other instrument—a violin, for instance. The corresponding note will sound on the piano. The resonator consists fundamentally of a telephone transmitter and receiver, facing one another and placed a short distance apart, the space between them being enclosed in a cylindrical casing which confines the air, thus amplifying the reaction between transmitter and receiver. To the back of the receiver is attached a tube in which works a piston operated by a short rod. By moving the piston in and out the length of the air column behind the receiver is changed, and consequently the note emitted when the diaphragms of transmitter and receiver are vibrated is altered correspondingly. The principle of the whole arrangement will be better and more easily understood by reference to the accompanying diagram. The telephone transmitter is coupled to the primary current and the receiver to the secondary current. From one of the terminals of the transmitter a wire runs through a suitable resistance, to a switch, hence through a battery, through the primary circuit of an induction coil, to an ordinary telephone relay, and from there back to the second terminal of transmitter. The wiring from the receiver is, it will be seen, connected up to the secondary circuit of the induction coil. When the armature of the relay moves over it provides short circuiting by the two wires shown in the diagram running to each side of the secondary coil.

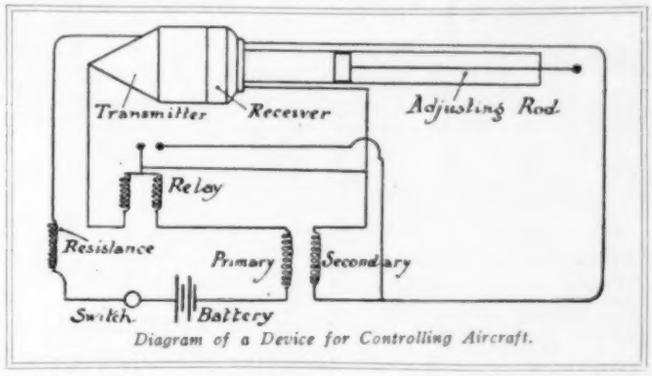


Diagram of a Device for Controlling Aircraft.

It will now be seen that when the diaphragms of the transmitter and receiver are vibrated by the proper note, determined by the position of the piston in the tube, and no other note will cause them to vibrate, the relay is brought into play and closes the local current which may then be used, via suitable means, of course, for starting or stopping an engine, operating control surfaces, releasing bombs, etc.

In the model framework of a dirigible on which the principle of distant control was demonstrated, there were, as we have already indicated, three small electromotors, each driving a propellor. As demonstrated the sequence of operation of the three motors was, in fact, predetermined by reason of the multiple switch employed for throwing them into gear, the same note being used for initiating the control of all the motors. When rigged up for actual use on aircraft each motor and movement would have its particular note, so that no fixed sequence would have to be followed. Thus, for instance, one note would correspond to right rudder, one to left rudder; one to elevating, one to depressing; one to accelerating the engine, and one to throttling it down. In this way any evolution of an aircraft could be controlled from the ground, the necessary notes being produced by some suitable instrument, as, for instance, a siren, in which the note could be altered by varying the speed of the siren. Care would, of course, have to be taken that no note likely to be produced on board the engines or by the bracing wires humming in the current of air, was employed for control. In fact, there seems to be no reason why notes of such a pitch as to be inaudible to the human ear should not be employed.

On the model demonstrated it was possible to set the machinery in motion by running up and down the scale until the right note was found. The inventor claims, however, that it would be a very simple matter to arrange a combination whereby it would be necessary to sound the given note, not once but several times, with predetermined intervals, before the result was obtained, thus providing in effect an equivalent to the combinations used on safes, and absolutely preventing outside interference. It is mainly in this respect, we understand, that the inventor claims superiority of the resonance method over the wireless system, in which latter a coherer must be used, and which is, therefore, open to the criticism that it may comparatively easily be interfered with.

As regards the practical utility of this very ingenious device to aircraft work, the number of forms this might take appear to be legion, and although many difficulties suggest themselves, doubtless they can be overcome. Even if they cannot, that does not detract in the least from the ingeniousness of the device. The inventor has, as already mentioned, ample scope for the application of the device to other fields of engineering. Thus, for instance, for telegraphic purposes the

resonator renders possible the sending of a great number of telegrams over one wire simultaneously, with the further advantage that "tapping" the wire can be made practically impossible. Communication can be maintained between a central station and each of a number of trains, thus minimizing the danger of collision, and there are numerous other applications possible, which we cannot deal with here.

How Users Can Help

Some of the Bell representatives are making the following suggestions to the telephone using public:

Consider the matter of enunciation when talking over the telephone. When we talk we usually have a mental picture of what we wish to say and it sometimes happens that we allow ourselves to say a thing mentally and then forget to put the thought into words. Then, too, we are not always careful to express our mental pictures distinctly. We forget that the telephone reproduces the exact sound of our voices. For instance, if instead of saying "What is it?" we crowd the three words together into the jumble, "What 'sit?" the person at the other end of the wire hears the jumbled combination of words and must hazard a guess as to just what was said.

Misunderstanding of our statements by the persons we talk with, is often blamed upon the telephone connection or the apparatus or the operator, when a moment's thought will make us realize that perhaps we ourselves may have been somewhat at fault. If a friend is walking along the street half a block away from us and we wish to call him, we naturally are careful to shout to him in a way that will make him hear our call and turn around. For example, we would not cry "Ohjim." We would separate the words carefully and say, "Oh-o-o-h! Jim!"

When we talk over the telephone, if we do not use the same care to speak clearly, the sound waves, which are produced when we speak into the telephone transmitter, crowd each other and overlap, and the result is a request from the person you are talking with, to repeat what you have said. It is wise to talk into the telephone with your lips about a half inch from the mouthpiece and to use a well modulated voice and a conversational tone. If your lips are more than an inch from the mouthpiece, you will find it difficult to tranmit the consonant sounds clearly, such as B, T, D, F, Z, and so on, and if the telephone is closer than half an inch from your lips, you cannot make your words sound clearly and the nasal sounds M and N in particular do not enter the transmitter in the way they should.

It may be interesting in this connection, to note the way telephone operators are taught to enunciate when repeating numbers given by subscribers. Their rule book shows the following ways to pronounce numbers:

1—Wun—with a strong N.
2—Too—with a strong T and long OO.
3—Th-r-ee—with a slightly rolling R and E.
4—Foer—one syllable, with a long O.
5—Five—with a long I and strong V.
6—Six—with a strong X.
7—Sev-en—with two syllables.
8—Ate—with a long A and strong T.
9—Nien—one syllable with a strong N on the end.
0—Oh—with a long O.

It is important to speak distinctly the digits composing a telephone number, because otherwise they are easily mistaken for each other. For instance, O sounds like four; one sounds like three, and five sounds like nine. You may have noticed that the operator in repeating a number that has the digit three in it, rolls the R. Her reason for doing this is to prevent confusing the numbers two and three.

So much has been said and written about the courtesy and efficiency of answering the call of the telephone bell promptly and of making sure to give the correct number to the operator by looking it up first in the telephone book, that it hardly seems reasonable to make any suggestions concerning these two points. People occasionally do forget to do either of these things. They are unmindful of the fact that an unfavorable impression is made upon the telephone caller who has to wait until you get ready to answer, and that calling an incorrect number involves more time in getting the right connection than is required for looking up the number in the telephone directory before calling "central."

There are a number of points in good telephone usage that sometimes are overlooked, though not one of them would be forgotten if each of us gave a little thought to the subject, with a view to helping ourselves to have better telephone service. Take for example the practice of identifying yourself or your department at once when you answer a telephone call instead of saying, "Hello." It saves a lot of time and enables you to get quick action. The storekeeper, who has his clerks answer the telephone with the name of his establishment instead of the old-fashioned "Hello" is sure to make his telephone serve him more satisfactorily.

Practicing the rules of correct telephone usage means full co-operation between the three parties to a telephone call, the one calling, the operator and the person called, and when the three work together, the result is service of the highest quality.

Gives Illinois Commission Dominance

Chicago's claims of power to regulate its own public utilities were knocked into a cocked hat April 19 by the Illinois Supreme Court at Springfield.

The high tribunal handed down a decision that the right of regulating Chicago public utilities has passed from the city council to the state public utilities commission, regardless of contract ordinances.

The immediate effect was to invigorate the movement to restore "home rule" to Chicago. Members of Mayor Thompson's cabinet and leading aldermen said the new city council should now get busy in backing such a measure. One is pending in Springfield.

In general they took the view that the holding has cleared the air of all doubt, that the city now knows where it stands, and that it will give impetus to the campaign for "home rule."

Corporation Counsel Ettelson will seek to carry the case to the United States Supreme Court, but the most promising source of relief lies in the legislature.

The court said:

"The regulation of public utilities is one phase of the exercise of the police powers of the state. The police power may be exercised by the legislature directly, or it may be exercised indirectly, by conferring the power upon agencies created by the legislature."

Joplin Zone System is Compromised

A refusal by the Joplin, Mo., Home Telephone Company to wipe out its zone rates was followed by the city compromise under the terms of which the zone will be widened to the east and southwest.

The company has described a circle around its plant with a radius of approximately one mile. Telephone rates within the zone are what the company terms its Joplin rates, but for each one-fourth mile that he is removed from the limits of the zone a subscriber is charged 35 cents additional to the regular rates.

The concession obtained by the city provides for an extension of the zone from St. Louis avenue to Florida avenue on the east, about half a mile, and south to Twenty-sixth street in southwest Joplin.

J. F. Lee, commissioner of public utilities, reported to the commission that he had failed to obtain the consent of the company to a request to abolish the additional charges, which have been approved by the Missouri public service commission, and outlined the concession offered by the company which the council accepted.

The company's contention is that outside of the zone, it is generally required to extend its lines over unplatted territory and that it cannot serve at a profit under such conditions as normal rates.

Wisconsin Rurals to Center in Exchange

A meeting was held at the Grantsburg, Wis., court house April 11 by representatives of the several rural telephone lines running into Grantsburg exchange, and of companies who are willing to connect with a Grantsburg rural exchange.

F. R. Huth was elected chairman of the meeting and J. E. Spangberg of Siren was chosen secretary. Mr. Huth stated the object of the meeting was to consider ways and means how to improve the service of the Grantsburg exchange, and asked for suggestions from those present as to how this might be best accomplished. A thorough discussion of the subject brought out the fact that it was the sentiment of a majority of those present that all the lines centering in Grantsburg should combine and build a rural exchange in the village, if it can be done, or outside the municipal limits, if it cannot.

The matter was left with a committee, who are to make a thorough investigation of the subject, then call meetings of the stockholders of the several lines for final action.

The committee are: Robert C. Anderson, Farmers Independent Telephone Company; Aug. Brask, Burnett County Telephone Company; Andrew Swanberg, Midway Telephone Company of Trade Lake; Yelmer Swenson, Trade River Telephone Company; D. K. Barrett, Marshland Telephone Company; Paul C. Olson, Logging Creek Telephone Company; Frank Bjorkman, West Sweden Telephone Company; J. E. Spangberg, Siren Independent Telephone Company.

J. E. Spangberg was made secretary of this general committee and will notify the other committee members when the first committee meeting will be held.

Denver's Difficulties Approach Solution

An amicable agreement between the Mountain States Telephone and Telegraph Company and the city of Denver, Colo., over mutual obligations in controversy several years has been provided in an ordinance introduced by Councilman W. C. Danks.

Telephone service rendered the city has been subject of disputes under former administrations, with the result that the company has paid nothing in revenues for inspection and police protection since 1914, and the city has not paid for service bills since 1915. Under the Danks ordinance the service to the city is placed on the same basis as private subscribers and a revenue of 2½ per cent of gross Denver exchange receipts is paid by the company to the city.

The acceptance of this revenue, it is specifically stated, in no way affects the rights of the city as to permitting the use of its streets and alleys, the basis of a suit pending in the United States Supreme Court.

Under the agreement a balance of $60,000 is due the city from the telephone company.

U. S. Needs Telephone Men

Colonel Samuel Reber, who is stationed at Chicago and is a brother of H. L. Reber of the Kinloch Independent Company of St. Louis, is ready to organize six signal corps battalions for the central department. Telephone and telegraph workers are needed especially. The Chicago Telephone Company and the Wisconsin, Cleveland and Michigan companies have promised to pay employes who enlist.

Telephones and the Sky Line

"If we had no elevators and telephones the sky lines of cities would be vastly different," said H. F. Hill, vice president of the Chicago Telephone Company, to the Electric Club-Jovian League. "Did you ever stop to think that without lifts and phones there could be no skyscrapers?"

Statement of the ownership, management, circulation, etc., required by the Act of Congress of August 24, 1912, of TELEPHONE ENGINEER, published monthly, at Chicago, Ill., for April 1, 1917.

State of Illinois, County of Cook, ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared E. R. Mock, who, having been duly sworn according to law, deposes and says that he is the Business Manager of TELEPHONE ENGINEER, and that the following is, to the best of his knowledge and belief, a true statement of the ownership and management of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor and business manager are:

Publisher, ELECTRICITY MAGAZINE CORPORATION, 1251-1256 Monadnock Bldg., Chicago.

Editor, PAUL H. WOODRUFF, 7025 Yale Ave., Chicago, Ill.

Managing Editor, PAUL H. WOODRUFF, 7025 Yale Ave., Chicago, Ill.

Business Manager, E. R. MOCK, 9345 Pleasant Ave., Chicago, Ill.

2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock.)

ED. J. MOCK ESTATE - - 9345 Pleasant Ave., Chicago, Ill.
B. C. SAMMONS ESTATE - - - - - - Blue Island, Ill.
JOHN CROCKER - - - - - - - - Maroa, Ill.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: There are no bonds, mortgages or other securities outstanding against TELEPHONE ENGINEER.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

ELECTRICITY MAGAZINE CORPORATION,
E. R. MOCK, *President*.

Sworn to and subscribed before me this 30th day of March, 1917.

(Seal) LEONA J. EKSTROM.

My commission expires Aug. 17, 1918.

Pennsylvania Bell Rates Ordered Down

A large increase in the number of city telephone users in Pennsylvania is generally expected as a result of the reduction in Bell Telephone Company rates, amounting to $450,000 a year in Philadelphia and an aggregate of $1,000,000 a year in the entire state, which was ordered by the Public Service Commission.

The opinions of telephone men also agree with the conclusions put forth in the order of the commission to the effect that the measured system of charging, whereby the subscriber pays only for actual use, tends to a more rapid development of telephone usage, and thus enables the telephone companies to extend their services to as large a portion of the public as is commercially possible.

The cut ordered, which is approximately five per cent of the annual gross earnings of the Bell company, will amount to a much larger percentage of cut in rates to small subscribers. The findings of the commission show that the same flat rate to each subscriber results in a benefit to the relatively few and a detriment to the many who use relatively few messages.

No period for the filing of the new schedule of rates is named in the order, but it is supposed that the reduction will be settled in conference between the company officials and the commission.

The order of the commission is said to be the most far-reaching ever issued in this state, ordering one of the largest reductions in toll rates obtained through the commission authority in any state of the Union. It is the result of four years of investigation, hearings and arguments. While the commission does not state it, the order is believed to be a compromise following the recent hearing of the Pittsburgh district case.

The commission ordered that the annual reductions be divided as follows: Philadelphia, $450,000; Pittsburgh, $300,000; and toll rates, $250,000. The reduction in toll rates will effect an equalization in these rates in all parts of the state. Large reduction in telephone rentals will result in Philadelphia and Pittsburgh, where these rentals are highest.

The order, which was signed by all members of the commission, holds that the telephone companies' properties must be considered on a state-wide rather than on a segregated district basis. The commission approves the measured service for business telephones as opposed to unlimited service rates in the larger cities, such as Philadelphia and Pittsburgh.

The telephone rate inquiry was begun by the old State Railroad Commission in 1913. Following the receipt of a large number of complaints, they decided to take up the entire question of telephone charges and equalize them if possible. The Public Service Commission, which succeeded the old one, took up the case, the decision being rendered April 5 after four years of hearings, testimony covering more than 10,000 typewritten pages and an expenditure of nearly $300,000 by the telephone companies producing testimony, employing experts, making exhibits rendering valuations and the like.

The commission recommends that each subscriber pay "according to the actual number of messages he sends" rather than a flat rate, which it says is "a benefit to the relatively few large users and a detriment" to smaller users. It ends with this recommendation:

"The telephone companies have allowed a continuation of existing flat rate contracts, but refuse to allow new subscribers the same privilege. This constitutes a discrimination as between the subscribers, and we are therefore of the opinion that the existing flat rate contracts should be eliminated and all subscribers should be treated alike."

The decision of the Public Service Commission ordering the Bell Telephone Company to reduce its rates in the state $1,000,000 a year will have no effect whatever on the Keystone Telephone Company, according to a statement made at the offices of that company.

It is pointed out that the decision is based on the complaint of certain telephone subscribers in Pittsburgh that unlimited service contracts were in force in the case of part of the telephone users but were not offered to others.

The opinion expressed by the commission adverse to the principle of unlimited service, it was stated, is entirely outside of the decision, and is merely interesting as showing the commission's attitude on the subject. No ruling was made compelling the elimination of unlimited telephone service for either business or residence telephones.

Chicago Telephone's Increases

During the first three months last year the Chicago Telephone Company gained 13,000 telephones, while for the same period this year the gain is 15,000, 12,200 in the city and 2,800 in the suburban division. The gain is in excess of 60,000 telephones a year, and is greater than ever before and fairly represents the feverish activity produced by the war conditions.

As a matter of fact, 28,000 telephones were put in in the three months, but 13,000 were taken out. A normal and satisfactory condition is to put in two telephones to gain one, but the showing is slightly better han this now. In 1914, when business conditions were bad, two telephones were taken out for every one put in, for several months, an this condition will likely return for a time at the close of the war.

There is a constantly increasing difficulty in adding new telephones because of the shortage of material of all kinds. The supply of about everything that goes into the building of a telephone exchange is about exhausted and little can be had even at almost double the old prices. There will be unusual delays in filling orders, and many cannot be filled at all.

Iowa Independent Buys Bell Rival

Negotiations have been in progress for several weeks between the Guthrie Center (Iowa) Mutual Telephone Company and the Bell Company, looking to consolidation of the two Guthrie Center exchanges. The Bell company has made a proposition to sell to the local company at a figure so reasonable that the board of directors of the Guthrie Center Mutual voted to accept the offer of sale and have authorized W. F. Moore to contract with the Bell Company for the purchase of the Guthrie Center system.

Should no hitch in the negotiations occur Guthrie Center will have but one telephone exchange, with many improvements the local company expects to install. It will be possible to have an almost complete county system. The Bell people have always been friendly to the Guthrie Center Mutual Company. When it was organized they helped the new company in every way possible. Later, when they bought out the Hawkeye interests they became a competitor in name only, and did not take the advantage of the Mutual that they were in a position to do.

Radio Methods for Cable Telegraph Receiving

By Louis W. Austin and Louis Cohen in the London "Electrician"

THE problems arising in the development of suitable instruments for the reception of signals in cable telegraphy and radiotelegraphy are very closely related. In either case the currents available at the receiving end are of very small magnitude, and in both cases sensitiveness and reliability of operation of the receiver are essential.

In the case of cable telegraphy direct currents or alternating currents of very low frequency, as in the Squier system, are used, while in radiotelegraphy currents of high frequencies are employed. It does not follow, however, that because currents of different character are employed in the two systems of telegraphy the same types of receiving instruments may not be used.

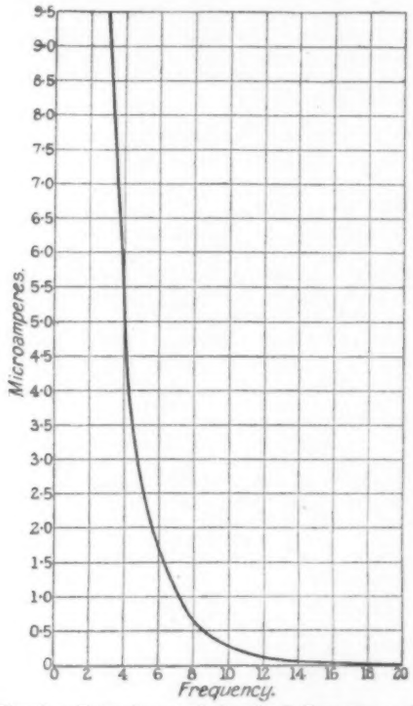


Fig. 1.—Showing Dependence of Received Current on Frequency.

It is wll known that the receiving instruments in radiotelegraphy, particularly the Audion and Ticker types, are of a far higher order of sensitiveness than those used in cabling, and it occurred to the writers that the same detectors might be also employed to great advantage in cable work. Experiments carried on in our laboratory demonstrated that the Audion or Ticker will make a suitable and far more efficient receiver than those employed now in cable telegraphy. With these receivers we can make use of audible reception or recording. We have found that the Audion operates as an oscillator for any frequency, even below the range of audibility, and by associating with it an oscillating circuit of suitable electrical constants, it can be made to oscillate with an audible frequency, the note of which is heard in telephones connected to it in the usual way. The received signal modifies the oscilliatory current, and the variation thus produced is heard in the telephones. Or the Audion may be adjusted for the critical point just short of oscillations, and the effect of the received signal is to start momentary oscillations in the Audion. In such an arrangement a current of 1 microampere is more than ample to give a readable signal, and even less than 1 microampere will suffice.

In case of the Ticker method the operation is somewhat different, the function of the Ticker being merely to interrupt the incoming current, rendering it audible, and thus make it possible to use telephones for the reception of signals. We have employed the slipping contact Ticker which was used by one of the writers a good many years ago for rendering direct current audible in telephones, and later for receiving radio signals. In the use of the Ticker we also found that less than 1 microampere will suffice to give a good readable signal.

In either of the above methods audible reception is not essential. Good results may also be obtained by using recording devices in place of the telephones, the recording device being preferably connected through a transformer to the detecting instrument. Further increase in sensitiveness may be obtained by using an Audion amplifier with either of the detectors mentioned above.

It is obvious, of course, that higher sensitiveness of receiver is desirable in any system of telegraphy, but it is particularly valuable in connection with the Squier system. In the latter system the speed of signaling is directly proportional to the frequency of the current employed, but for the same transmitting voltage the current at the receiving end decreases very rapidly as the frequency is increased. In Fig. 1 a curve is given, showing the decrease in received current for a transatlantic cable for increasing frequency. For a frequency of 20 the current at the receiving end is about 0.3 microampere for 100 volts at the transmitting end, and, therefore, it is only with highly sensitive detectors that any such frequency could be employed for cable work.

The combination of the use of alternating currents and highly-sensitive detectors offers the additional great advantage that the solution of the problem of multiplexing can be realized. It must be remembered that in direct-current cabling all improvements in regard to increase in sensitiveness and speed are controlled by the accuracy with which the duplex bridge may be balanced. The opening and closing of the circuit in signaling induces transient effects which are difficult to balance accurately. This was recognized by Col. Squier, and he brought it out very clearly in his paper in the following statement: "In the last analysis it was always the opening and closing of the transmitter circuit which produced the final kick or 'jar' in the balance. This is not surprising when we remember that, from an electrical standpoint, few things can be done to a circuit more severe than suddenly to introduce an infinite resistance into it. . . . It was only after many variations of the simple alternating current had been tried in the course of experiments to perfect the duplex balance of the bridge that the fundamental principle of never breaking the transmitter circuit became impressed." The use of an unbroken alternating current eliminates many of the difficulties in balancing which were considered heretofore as inherent in duplex cabling, and also simplifies the problem of multiplexing.

In conjunction with Col. Squier the writers developed a method by which an extra simplex system is superimposed on a Squier duplex cable. The arrangement of circuits used is shown in Fig. 2. As is seen, we have at the two ends of the cable stations *A* and *B* equipped for duplexing, and in addition we have stations *D* and *C*, where one acts solely as the transmitter and the other as the receiver, constituting the superimposed duplex system. In the simplex system, which we designate by *D C*, audible reception is used. The frequency of the current may be either within the range of audition or below audition, and rendered audible at the receiving end by a Ticker or Audion, the frequency of the current being comparatively high, say 15 or more. The current used in the duplex system is of low frequency. The two receiving circuits at *B* and *C* are tuned for the corresponding frequencies of the signals which are to be received at the respective stations, and since the frequencies used in the two cases are considerably different, the tuning of the circuits will iusure responsiveness of each receiver only to the current of the signal, which is to be received at each station.

To eliminate the effect of transmitter *B* in receiver *C*, the receiving circuit is coupled to the bridge arm of the artificial cable as well as to cable, and the secondaries so

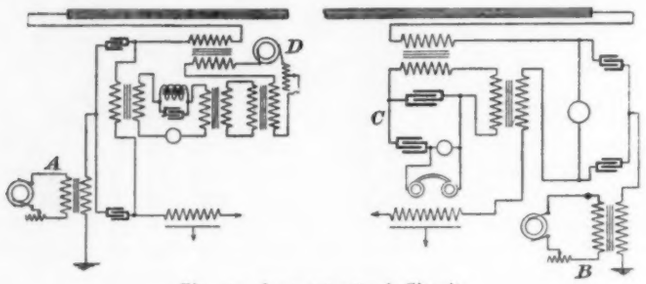


Fig. 2.—Arrangement of Circuits.

connected as to induce equal and opposite E.M.F.'s in the receiving circuit, thus neutralizing the effect of transmitter *B* on receiver *C*. A little different arrangement is employed to eliminate effect of transmitter *D* on receiver of station *A*. In addition to double transformers, which neutralize each other's effects, a loop circuit tuned to the frequency of transmitter *D* is also introduced in receiving circuit of station *A*, thus rendering it opaque to currents of frequency produced by station *A*. In this way it becomes perfectly feasible to superimpose an extra simplex circuit on a duplex cable. By suitable modifications of transformers and tuned circuits, and also making use of different frequencies, it is possible to develop a system in which a number of simplex systems are superimposed on a duplex cable.

We have only given a general sketch of the work being carried on in making use of these new types of detectors and multiplexing for cable telegraphy. Various arrangements and modifications are being developed, but cannot be discussed at present in detail. It was thought, however, that it would be of interest to engineers to bring to their attention this new development work in cable telegraphy.

In all this work we had the valuable co-operation of Col. G. O. Squier.

A delegation from an auxiliary formed by employes of the Chicago Telephone Company called at the Red Cross Shop, 60 East Madison street, Chicago, and tendered the services of 400 telephone girls for field hospitals.

Southern States in Convention

The Southern States Independent Telephone Association held its annual convention at Louisville, Kentucky, May 24 to 26. Following is the program of the convention:

THURSDAY, MAY 24

9:30 A. M.

Meeting of Board of Directors.

10:00 A. M.

Address of Welcome.

Reply to Address of Welcome—Dr. W. L. Moor, Tallahassee, Florida.

"Service Methods" by Rollo Stevens, Ohio State Telephone Company, Columbus, Ohio.

"Manufacturing Telephones" by J. B. Wilkinson, Stromberg-Carlson Telephone Manufacturing Company, Louisville, Ky.

Report of President.

Report of Secretary-Treasurer.

Appointment of Committees.

1:00 P. M.

Convention convenes promptly.

"Hints and Suggestions" by Mr. Wm. Fortune, Indianapolis Telephone Company, Indianapolis, Ind.

"Workmen's Compensation and Liability Insurance for Public Utilities"—Lynton T. Block, St Louis, Mo.

"What We Are Striving For"—by W. H. Bryant, Home Telephone Company, Mobile, Ala.

6:00 P. M.

Visiting Exhibits.

8:00 P. M.

Smoker.

FRIDAY, MAY 25.

9:30 A. M.

"The United States Independent Telephone Association, Its Aims and Objects"—W. S. Vivian, Secretary U. S. I. T. A., Chicago, Ill.

"The Relation of the Interstate Commerce Commission to Telephony" by Hon. Joseph W. Folk, Chief Counsel for Interstate Commerce Commission, Washington, D. C.

"Accounting," by W. M. Brown, General Auditor of Louisville Home Telephone Company, Louisville.

Election of Officers.

1:00 P. M.

Convention convenes promptly.

"The Effect of Mergers Upon Independent Telephony From a Legal Standpoint," by Bruce A. Campbell, Attorney for the Kinloch Telephone Company, East St. Louis, Ill.

"Where We Are Drifting," by Terry W. Allen, President Allen Properties, Jackson, Tenn.

3:00 P. M.

Auto Ride Seeing Louisville.

SATURDAY, MAY 26

10:00 A. M.

Convention convenes promptly.

"Valuation and Reports," by F. B. MacKinnon, Vice-President of U. S. I. T. A., Washington, D. C.

"Advertising Methods," by Edward I. Pratt, Kellogg Switchboard & Supply Company, Chicago, Ill.

"The Manager's Job," by B. Y. Chambers, Paduach Home Telephone Company, Paducah, Ky.

Protecting the Telephone

In the present crisis, with water works and other municipal improvements being carefully guarded, it is well to note that the telephone has not been overlooked, and is receiving every safeguard against possible harm.

Permission has been withdrawn from the public to visit most telephone exchanges, all over the country, and extra precautions have been adopted to guard the switchboards. That so much precaution is taken against accidents is due to two reasons: one of these is that there is an absolute scarcity of switchboards and other telephone materials.

In view of their tremendous value to the nation at large, the telephone lines all over the country will be guarded as the railroads and tunnels will be.

Skin Effect Resistance Measurements

Conductors at Radio-Frequencies Up to 100,000 Cycles Per Second

BY A. E. KENNELLY AND H. A. AFFEL

The research here reported was conducted in the Research Division, of the Electrical Engineering Department of the Massachusetts Institute of Technology, during 1915-16, under an appropriation from the American Telephone and Telegraph Company. The object of the research was to obtain experimental data on the alternating-current resistances of various electrical conductors at frequencies up to 100,000 cycles. Presented as the Presidential Address before The Institute of Radio Engineers, New York.

THROUGH the courtesy of Dr. Goldsmith, a sample of "Litzendraht" wire, 13 millimeters long, was secured for test. This wire is constructed by braiding enameled copper wires, stocking fashion, in the form of a continuous long cylinder. This sample contained 48 number 38 copper strands, in groups of 3 each. Each strand had a diameter of approximately 0.1 millimeter, enamelled to about 0.12 millimeter. Such a basket braiding necessarily provides a certain central air space, of diameter depending on the braiding and tension. The external diameter, under a heavy braiding of silk, was approximately 1.15 millimeter (0.045 in.), representing a diameter enlargement ratio of nearly 1.7. Such a construction involves a transposition of strands at regular intervals, between the inner and outer layers, also a hollow cylindrical cross-section. The results of the test of this sample are given in Figuer 13. The total cross-section of conductor is approximately 0.38 square millimeter, or nearly the same as in the previous case, but the skin-effect resistance ratio is only 1.016 at 100,000—.

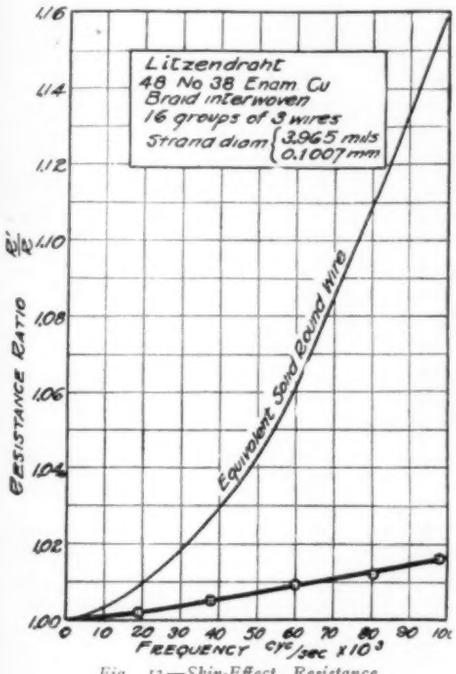


Fig. 13.—Skin-Effect Resistance Ratio for Litzendraht.

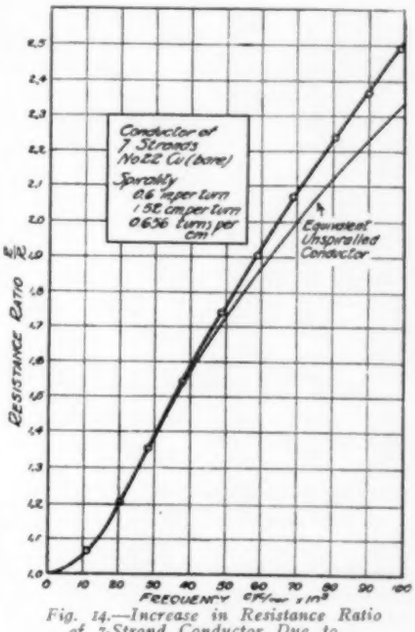


Fig. 14.—Increase in Resistance Ratio of 7-Strand Conductor Due to Spirality.

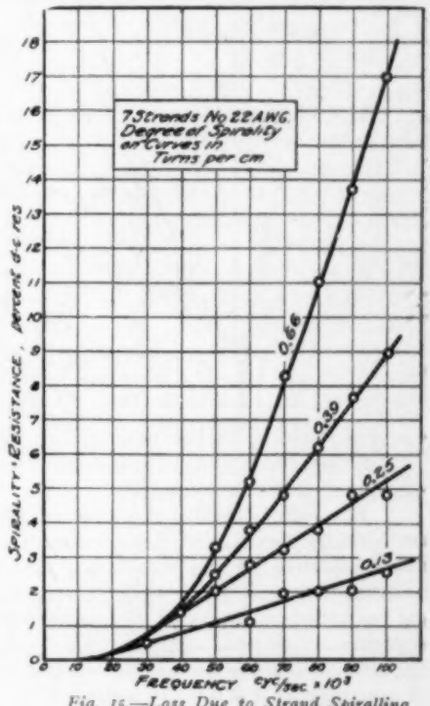


Fig. 15.—Loss Due to Strand Spiralling for Different Degrees of Spirality.

Spirality Effect in Stranded Wires.—Through the courtesy of the Simplex Wire and Cable Company, six samples of stranded bare copper wires were obtained, and of the same particulars and construction, except in regard to the degree of spiralling or lay. It was considered desirable to ascertain, with the aid of these conductors, the influence of spiralling upon their skin-effect resistance ratio. It had already been ascertained that the resistance of a 7-strand conductor, with the strands uninsulated, and in contact without spiralling, is the same as that of the solid equisectional round wire of the same metal and temperature. Consequently, and increase in the resistance ratio of 7-strand uninsulated and spiralled conductors may be attributed to spirality effect, assuming that the extra length of the external strands in the spiralled conductors was taken into account.

Each of the six special test conductors was 25 meters long, and consisted of seven strands of bare tinned copper wires, each number 22 A. W. G., of diameter 0.668 millimeter (0.0263 in.), made up in the usual manner by a stranding machine, except in regard to the lay. The lay varied between 1 turn in 7.62 centimeters, to 1 turn in 1.52 centimeter; *i. e.*, a spirality of 0.131 to 0.656 turns per centimeter. To assist in maintaining insulation between these bare copper strands, they were passed through oil before entering the stranding machine in each case. They were then braided and thus held closely in contact.

As might be expected, it was found that the skin-effect resistance ratio, at any one frequency, such as

100,000—, increased with the spirality. Figure 14 shows the results obtained with the conductor of greatest spirality (0.656 turn per centimeter). At 100,000—, the observed resistance ratio was 2.51; whereas the ratio computed for an unspiralled conductor of the same linear resistance was 2.34. This is the maximum deviation observed among the six samples tested. The corresponding curves for the other samples are omitted, partly because they would lie very close together, and partly because they are not strictly comparable on the same curve sheet, owing to small differences in d. c. linear resistance. In the case of the sample with least spirality, the resistance ratios were 2.41 observed and 2.38 computed for the solid wire.

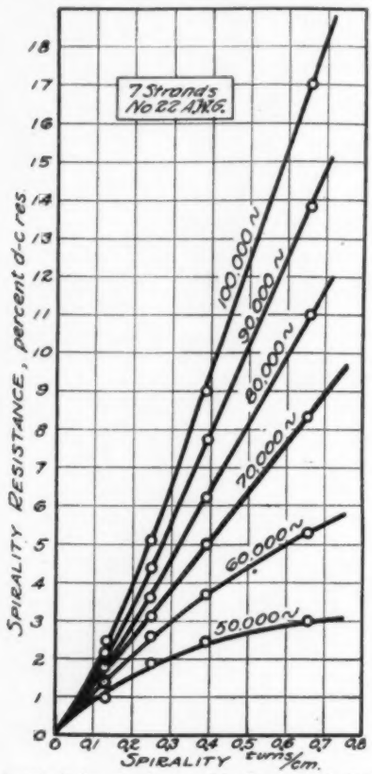


Fig. 16.—Variation in Loss with Degree of Spiralling.

The extra linear resistance of spirality may, perhaps, as already mentioned, be attributed to loss of power in the substance of the conductor accompanying the longitudinal magnetic field within the spiral. It may therefore be regarded as an extra percentage of the d. c. linear resistance at normal temperature. On this basis, Figures 15 and 16 have been drawn. Figure 15 shows the extra percentage resistance of spirality in four different samples plotted against different frequencies; while Figure 16 shows the same percentage resistance at six different frequencies, plotted against spirality. The figures magnify the spirality effect at the expense of some apparent loss in precision. It will be seen that the spirality effect is almost negligible up to 30,000—. Above 50,000—, the spirality extra resistance is roughly proportional to the spirality, especially in the neighborhood of 70,000—.

Summing up the results for stranded wires, it appears that the mere subdivision of a solid round wire into seven uninsulated parallel round strands has no appreciable effect upon the skin-effect resistance ratio. The separation of the strands, as by their insulation, rapidly diminishes the resistance ratio, but increases the reactance ratio of the conductor. Spiralling the strands, to the extent ordinarily employed, slightly increases the resistance ratio.

Copper Strips.—Several samples of copper strip 0.003 inch (0.0076 cm.) were supplied by the courtesy of the Western Electric Company. These were tested in various widths from \$.356 centimeter to 3.8 centimeters (0.14 inch to 1.5 inch). The observed skin-effect resistance ratios are indicated in Figure 17, for five different widths of strip, the abscissas being impressed frequencies, and the ordinates R'/R. Each tested strip was mounted in a horizontal loop, or loops, on the testing-room wall. The length of each tested loop varied about 3 meters, for the narrowest strip, to 25 meters for the widest strip. The spacing between the sides of the loop or loops varied from 10 to 20 centimeters, and the proximity effect was found to be negligible under these conditions. It will be observtd that at 100,000—, the resistance ratio varies from 1.08 for the 0.356-centimeter strip width to 1.44 for the 3.8-centimeter width. Owing to slight differences of thickness and of test temperatures the curves are not precisely comparable; but they resemble the curves of resistance ratio for wires of increasing diameter, and the extra

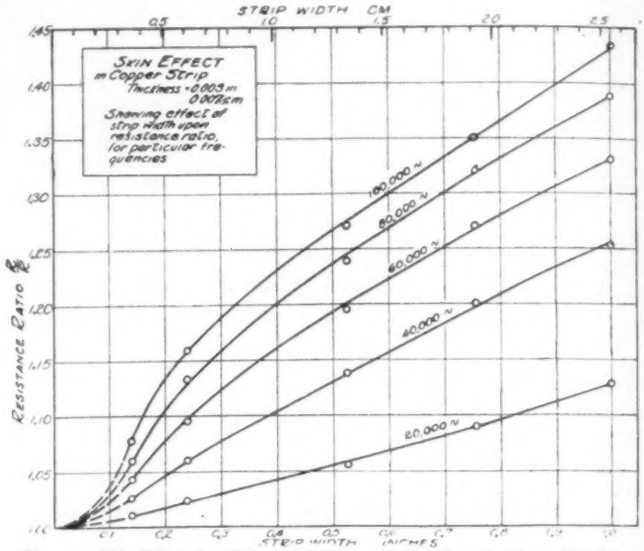


Fig. 17.—Skin Effect for Strips of Different Width But the Same Thickness.

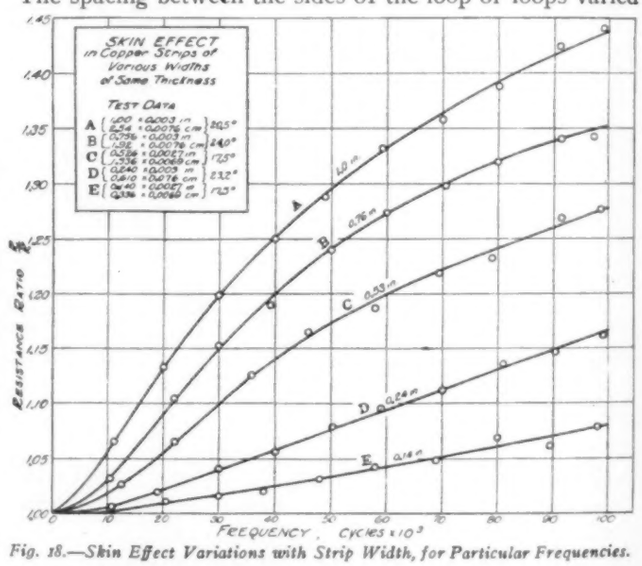


Fig. 18.—Skin Effect Variations with Strip Width, for Particular Frequencies.

resistance is, to a first approximation, proportional to the width of the strip. This relation is presented more clearly in the series of curves of Figure 18, which are taken from the last figure, for selected frequencies. The abscissas are strip widths, in inches and cm., and the ordinates are resistance ratios. The curves are seen to be, within the limits of frequency presented, rough approximations to straight lines, particularly in the neighborhood of 30,000. It is evident that for 0.76-millimeter strip, the effect of increasing width is to increase the resistance ratio in somewhat the same manner as increasing diameter in a round wire, so that a 4-centimeter strip at 100,000~ is by no means twice as good a conductor as a 2-centimeter strip. A strip at radio frequencies is, however, always a better conductor than an equisectional round wire of the same material. Thus, Figure 19 shows the resistance ratio of the 3.8-centimeter strip, by comparison with that of an equisectional round wire 0.192 centimeter in diameter. Up to the frequency of 16,000~, the round wire is the better conductor; but for all higher frequencies, the strip shows distinctly increasing advantage.

Similar tests were made upon samples of strip 0.16 millimeter thick (0.0063 in.) and of widths from 0.64 centimeter to 3.81 centimeters. The comparison between these strips and the solid round copper wire, equisectional

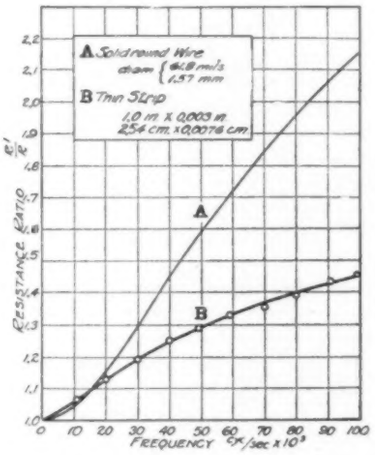


Fig. 19.—Comparative Skin Effects of Thin Copper Strip and Equisectional Round Copper Wire

to the widest, is shown in Figure 20. It will be observed that the curves are of the same general appearance as those for the 0.76-millimeter strips, yet they rise somewhat higher, owing to greater skin-effect in thickness.

Formulas for Skin-Effect in Strips.—It has been already pointed out that the Rayleigh skin-effect formula for indefinitely wide strip is quite inapplicable to single strips of ordinary widths. For particular ranges of dimensions and frequency, empirical formulas have recently been suggested. It is evident experimentally that a long flat strip, carrying an alternating current, sets up a more or less cylindrical magnetic flux distribution about the center, which flux intersects the strip itself. This must give rise to eddy-current e. m. fs. in the strip. If these e. m. fs. produce local eddy-currents in the strip, they would tend to increase the power loss and the effective a. c. resistance. If, however, they produce oling the entire length of the strip an organized e. m. f. distribution, the effect will be to crowd the current toward the edges of the strip, and away from the center; thus producing what may be called an *edge-effect*, perpendicular to that plane.

In order to ascertain which eddy-current action predominated, the local eddy-current effect or the edge-ef-

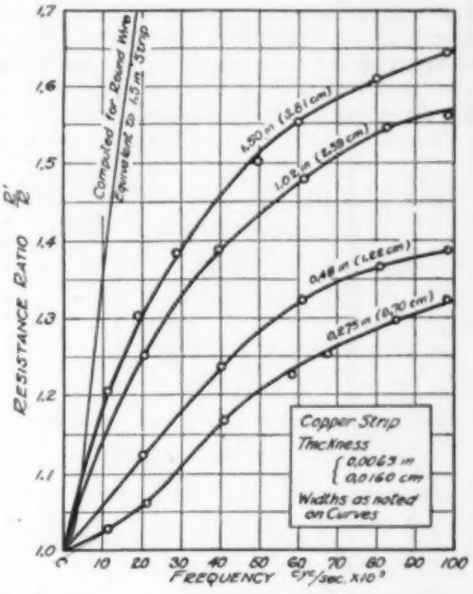


Fig. 20.—Skin-Effect for Strips of Different Width but the Same Thickness.

fect, a sample of copper strip 2.22 centimeters wide (7/8 inch) and 13 meters long was slit longitudinally near the edges with a sharp knife, in the manner indicated in Figure 21. These slits were from 6 to 8 centimeters long, and then ceased for a distance of about 0.5 centimeter, the gaps in the slits overlapping one another, so as to maintain the structural rigidity of the conductor, while at the same time greatly hampering the circulation of eddy-currents across the strip. A strip of similar dimensions was also mounted without any slits. Up to 100,000~, no appreciable difference could be detected in the skin-effect resistance ratios of the slitted and unslitted strips. The inference may, therefore, be drawn that the large increase in skin-effect resistance ratio, observed in copper strips, with reference to what should be found in infinitely

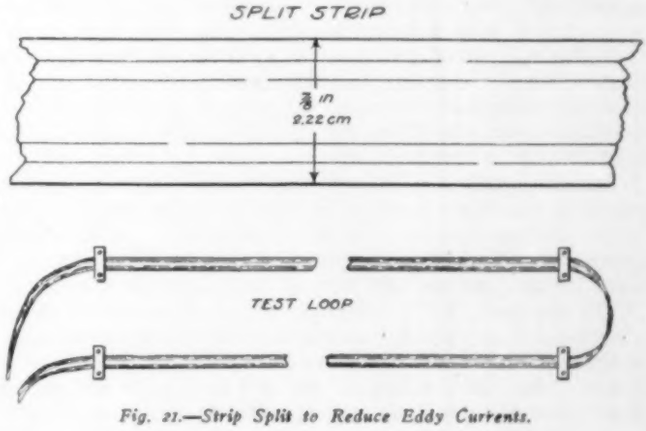


Fig. 21.—Strip Split to Reduce Eddy Currents.

wide strip, is attributable, at least in large measure, to edge-effect.

We may, therefore, consider, for purposes of discussion, that any long, straight conductor of rectangular cross-section, such as a bar, prism, strap or strip, has a

skin-effect in two directions, namely, across its thickness and along its width. The former is commonly regarded as a skin-effect, and the latter may be called, in contradistinction thereto, an edge-effect; but actually, the two effects are essentially manifestations of one and the same phenomenon; that is, a tendency of alternating current to leave the center, and to crowd into outlying positions of the cross-section. This distortion of current density may be regarded in either of two ways, namely (1), as due to imperfect penetration of the current from the outlying

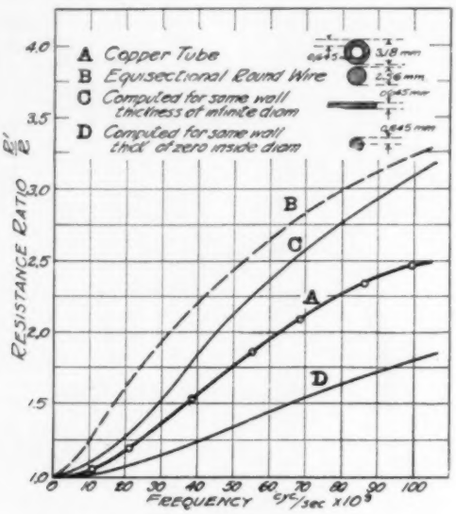

A Copper Tube
B Equisectional Round Wire
C Computed for same wall thickness of infinite diam
D Computed for same wall thick. of zero inside diam
RESISTANCE RATIO
FREQUENCY

Fig. 22.—Skin-Effect in Copper Tube.

positions toward the center, (2), as due to the opposing mutual inductive influence of parallel filaments, whereby the retarding and diminishing effects of mutual inductive inductance are greatest at the center, and least at most remote points. According to either of these ways of viewing the matter, it must appear that the tubular form of conductor can be made to offer the minimum skin-effect at any given frequency, by reducing the wall thickness to a minimum. In the case of a rectangular section, however, the advantage of thinness may be overbalanced by the disadvantage of width, the edge-effect increasing as the skin-effect is reduced. There will thus be a best form of cross-section for each particular cross-sectional area, and frequency.

Parallel Opposed Strips in Close Proximity.—In view of the interesting fact that in the case of a pair of parallel going and returning flat strip conductors, in close juxtaposition, one above the other, and separated only by a strip of thin insulator, the skin-effect resistance ratio at frequencies below 5,000— is much lower than when the strips are widely separated, it seemed important to check this result at frequencies up to 100,000—. It has been pointed out by H. B. Dwight that the data for such surface-juxtaposed parallel strips, published in the A. I. E. E. paper of 1915, follow a certain formula which he developed, and which, as pointed out in Appendix IV, coincides with the formula for infinite strips given in that paper, when X is taken as the full thickness, instead of the half thickness of the strip, as is necessary for infinite widths:

$$\frac{Z}{R} = \frac{aX}{\tanh(aX)} \quad \text{numeric} \angle \quad (2)$$

This case constitutes the first reliable skin-effect formula for flat strips of finite width known to the writers. Available formulas for finite strips seem to be all based on Rayleigh's infinite-strip formulas, and are therefore open to very large correction for edge-effect.

The test was made with a loop 6.1 meters long, of two flat strips, each 2.54×0.0076 centimeters (1.0× 0.003 inch) laid on a flat board, the lower strip being entirely enveloped in tissue paper 0.0038 centimeter (0.0015 inch) thick, and the upper strip laid carefully over this, so as to keep the edges parallel. Little bindings of paper were then applied to the two insulated strips, after which weights were applied uniformly to the system. Great care had to be taken to secure good alignment of the edges in the opposing strips, since it was found, in preliminary trials, that a relatively small amount of overprojecting at the edges added materially to the losses and apparent resistance of the loop.

The d. c. resistance of the loop at 20° C. was 0.012 ohm,, and the a. c. resistance at 93,000— was the same, within the limits of observational error; so that the skin-effect resistance ratio up to this frequency was sensibly 1.00 In such a disposition of conductors, virtually forming a paper condenser, the susceptance of the dielectric may have an appreciable effect on the measurement. In this case, however, the loop was so short that the error due to capacity susceptance was negligible.

Copper tubes are of especial interest in relation to skin-effect; since, as already mentioned, their resistance ratio should be capable of being made lower than that of any other form of conductor. A tube of large diameter and very thin wall should presumably have a skin-effect resistance ratio calculable on the basis of infinitely wide strip with X, see formula (2), taken as equal to the wall thickness.

Two copper tubes were tested. One was a slit tube of 2.22 centimeter (⅞ inch) perimeter, made by rolling a length of the thin flat strip previously tested (2.22 cm. wide × 0.076 mm. thick) over a cylindrical wooden

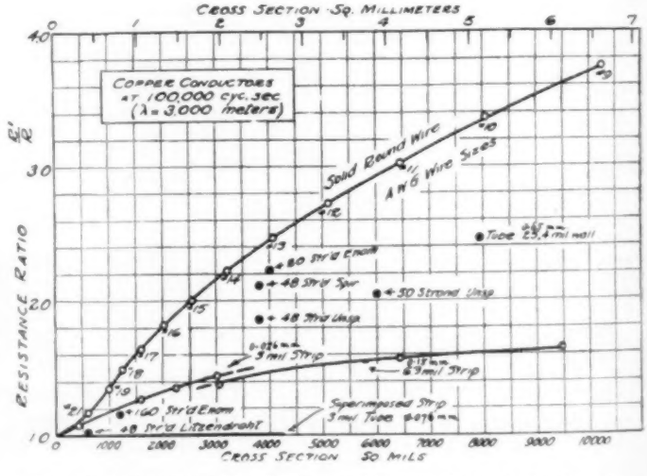


Fig. 23.—Comparative Skin-Effects for Different Types of Conductors.

form. This produced a slit copper tube 12 meters long, and of an external diameter approximately 7.2 millimeters. The calculated skin-effect resistance ratio of 0.076 millimeter copper strip of indefinitely great width is, by (2) 1.005 at 100,000—. When the tube conductor made of this strip was tested at 100,000 , its skin-effect resistance ratio was found to agree with this value, within the limits of observational error. The same strip, when tested flat, before being rolled into tube, was found to

give 1.38 at 100,000 . This experiment gave a striking demonstration of the influffence of edge-effect in one and the same single loop of copper conductor. With the edge-effect present in the flat strip, the a. c. resistance at 100,000 was nearly 40 per cent greater than the d. c. resistance. With the edge-effect removed, by bending the same strip into a simple slit tube, the a. c. resistance, at the same frequency, was hardly greater than the d. c. resistance.

The second tube was of a soft drawn continuous copper tube of external diameter 3.18 millimeters and of wall thickness 0.65 millimeter (number 22 A. W. G.). Its length was approximately 25 meters, in two horizontal loops, or four horizontal passages, along the wall, with an interaxial distance of about 20 centimeters between adjacent conductors.

Figure 22 shows the observed skin-effect resistance ratios at this tube at various frequencies up to 100,000⁓. It will be observed that at 100,000⁓, this ratio is 2.46. The round wire of equivalent cross-section, shown in dotted lines, would have, at the same frequency, a ratio of 3.17. The curve *C* shows the computed ratios for infi-

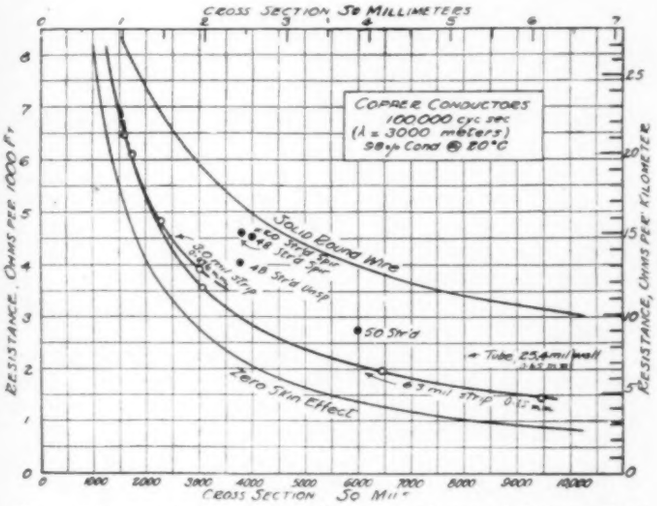


Fig. 24.—Comparative Linear Resistances of Conductors of Different Types at 100,000 Cycles.

nitely wide strip, of the same thickness (0.65 mm.), that is, a tube of infinite diameter and this wall thickness; while curve *D* shows the corresponding ratios for a tube of zero internal diameter; that is, a solid wire of radius 0.65 millimeter. It will be seen that the curve *OA* of observations lies nearly midway between the curve of infinite internal diameter and of zero internal diameter, having the same wall thickness, on the assumption that the magnetic flux density vanishes within a uniform straight hollow cylinder carrying a current. The curve *OA* corresponds very closely to formula (2) when *X* is taken at 82 per cent of the actual wall thickness.

Comparisons of Skin-Effect Resistance Ratios for Different Types of Conductors.—When an alternating current of radio-frequency has to be carried with the least loss for a given amount of copper, it is evident that the skin-effect resistance ratio must be made as near unity as possible. It is therefore important to consider what form a cross-section of given number of square millimeters of copper should have, in order to make the conductor most efficient. The best form of the conductor will depend to some extent upon the frequency.

For the particular frequency of 100,000⁓, Figure 23 shows the skin-effect ratios of various kinds of geometrical section. The ordinates are in R'/R. The abscissas are in square millimeters, and also in square mils (10^{-6} sq. inch) of copper cross-section. It will be seen that round solid wire has the greatest resistance ratio throughout almost the entire range of cross-section shown, although spiralled 7-strand conductor, devoid of internal insulation, would have a resistance ratio in excess of this by an amount depending on the degree of spirality. All other forms of conductor, for a given cross-section, have less resistance ratio.

The few tests thus far made of stranded conductors are plotted on the diagram. The diminution in resistance ratio depends upon the number of strands, their internal transposition and separation. Below most of these come three-mil (0.0076 mm.) copper strip, which is not so low as six-mil (0.15 mm.) strip. As already explained, the edge-effect of three-mil strip, which must be twice as wide as six-mil strip for the same cross-section, predominates over skin-effect at 100,000⁓, so that there is a disadvantage, within the limits of cross-section shown, in rolling 0.15 millimeter strip into 0.075 millimeter strip for 100,000⁓. The limit of thickness to which flat strip should be rolled, for a given cross-section, is evidently a function of the frequency, which determines the equivalent penetration skin-depth δ. The tests have not yet been carried sufficiently far to assign the economical thickness limit; except that, at 100,000⁓, it is above 3 mils (0.076 mm.) for cross-sections less than 6 square millimeters.

The only apparent means of avoiding the edge-effect, so as to permit of using very thin sheets of conductor, is either to use two opposing parallel strips in close proximity; or to roll a single strip up into circular tube-form. In either case, as Figure 23 shows, the resistance skin-effect ratio of 0.075-millimeter strip fell to almost 1.0. The use of opposing juxtaposed parallel strips, as going and returning conductors, has limitations, owing to the large capacitance involved. No matter how high the frequency, there seems to be no electrical limit to the reduction of extra skin-effect resistance, by using tubular conductors of sufficiently thin wall. Mechanical considerations suggest that this might best be accomplished by using a flexible insulating core with fine copper wires braided over the surface. In such a flexible conductor, by taking thin enough wire, and avoiding spirality effects, the skin-effect should be reduced indefinitely, since there could be no edge-effect.

The data contained in Figure 23 are presented in a somewhat different form in Figure 24, which shows the total linear resistance of copper conductors of different types of cross-section at 100,000⁓ and 20° C, for different cross-sectional areas as abscissas. By reference to this diagram, the most suitable conductor can be chosen for this particular frequency, so far as the experimental data, thus far obtained, will permit.

SUMMARY

The following conclusions have been reached from tests at frequencies up to 100,000 , on straight conductors, shielded from proximity effects, and of cross-sections up to 6 square millimeters.

(1) The skin-effect resistance ratio of round copper wires has been found to conform to the standard Heaviside-Kelvin Bessel-function formulas, within the limits of experimental error.

(2) The skin-effect resistance-ratio of a copper conductor formed of seven equal and parallel round bare strands (six surrounding a central seventh), was found to be the same as that of the equisectional solid round wire up to 100,000⁓, within the limits of observational

error. It is therefore inferred that the subdivision of a round wire into a round cable of uninsulated contacting strands does not alter the skin-effect.

(3) The effect of simple spiralling of strands in the same direction increased the resistance ratio.

(4) The resistance ratio of a subdivided wire, with parallel insulated strands, fell below that of the equisectional solid wire, and diminished rapidly with the spacing, or degree of strand separation.

(5) The braiding of strands, so as to effect their transposition in the cross-section at frequent intervals, was found to diminish the skin-effect.

(6) The skin-effect in copper strips was found to be usually but not invariably less than that of equisectional round wires.

(7) Increasing the width of a copper strip within the limits reported, was found to increase the skin-effect resistance ratio; owing to what may be called "edge-effect."

(8) A pair of parallel going and returning flat strips, separated by a thin insulating layer, was found to have a skin-effect depending only on the strip thickness; that is, without perceptible edge-effect.

(9) Rolling a flat strip into the form of a slit tube destroyed the edge-effect, and reduced the resistance ratio to a minimum, dependent only on the strip thickness.

(10) Cutting longitudinal slits with a sharp knife in a thin flat copper strip was found not appreciably to affect its skin-effect resistance ratio.

(11) In order to employ a stranded wire of minimum skin-effect at radio-frequency, it seems desirable to employ thick insulation on the strands, such as double cotton, to transpose the strands by braiding, and to avoid spirality in one and the same direction.

(12) In order to employ a flat strip conductor most effectively, it is necessary to stop rolling it out laterally when the increasing edge-effect more than offsets the reduction in skin-effect.

(13) The hollow tubular form seems to be the most efficient type of radio-frequency metallic conductor, since, with proper mechanical internal support, the skin-effect can be indefinitely diminished by diminishing the wall thickness, and the edge-effect is absent.

Texas Independents Voice Patriotism

At a meeting April 4 at Waco, Texas, of the officers and directors of the Texas Independent Telephone Association, the secretary of the association, E. C. Blomeyer of Waco, who is also secretary of the Texas Telephone Company, was instructed to notify each of the 1,073 Independent plants in Texas that they will be called upon, in case of war, to use their entire property, if necessary, for the benefit of the government, and in defense of the country.

R. B. Still of Tyler, president of the association, presided at the meeting, which was attended by all but three of the officers and directors.

Secretary Blomeyer read a telegram, received from F. B. MacKinnon, Washington, D. C., vice president of the United States Independent Telephone Association, and member of the National Council of Defense, Committee on Communications, requesting the absolute co-operation of every Independent telephone company in Texas. The message was cheered and approved by a unanimous vote of those present.

According to Mr. MacKinnon, well-thought-out measures for use of all communication lines by the government have been prepared. It is the intention of the government to recruit signal corps from among the telephone and telegraph men, and a reserve signal corps will be formed from among the older men of the telegraph and telephone companies.

There was general discussion of plans for work on the part of the Texas Independent Telephone Association, during the present year. District meetings will be held during the present year in Waco, Tyler, Greenville, Denison, Brownwood, Austin and other cities. The 1918 convention of the association will be held in March, the place not having yet been decided upon. Invitations have been received from Marlin, Galveston, Dallas, Fort Worth, San Angelo and Brownwood. The next meeting of the directors will be held at Galveston in July.

Following the sessions the officers and directors of the association were dinner guests at the Raleigh of the Texas Telephone Company.

Present at the meeting were President Still, Vice Presidents F. W. Greber, Brownwood; A. J. Combs, Haskell; Secretary E. C. Blomeyer, Waco; Membership Secretary L. S. Gardner, Waco; Treasurer E. M. Powell, Dallas. Directors J. W. Ozment, Palestine; J. Y. Rust, San Angelo; A. V. Ward, Pflugerville; C. D. Longserre, Bardwell.

Florida Bell Has Merging Franchise

The right of the Southern Bell Telephone & Telegraph Company to purchase and maintain all the local telephone lines and to operate a system of its own, was granted in Daytona, Fla., April 3, at a special election held for the purpose of ratifying the favorable action of the commissoiners who passed on the question several weeks ago. The vote was 74 for the Bell franchise and 6 against.

In the election, which was held at the expense of the Bell company, 84 of the 127 qualified electors voted. Four votes were thrown out, leaving the final count a ratification of the franchise grant by 68 votes.

Minnesota Toll Rates Unchanged

Minnesota toll rates will stay as they are until changed by the railroad and warehouse commission. The state senate April 12 defeated by a vote of 28 to 41 the bill providing that toll rates in effect on April 1, 1915, should be put in effect again. Rates were raised throughout the state by the telephone companies on July 1, 1915, just before the law went into effect providing that they should not be changed except on authorization of the railroad and warehouse commission.

Many senators voting against the bill explained that they did so because they believed it would not be effective. A valuation of telephone company property is needed on which to case a new tariff, senator-lawyers declared.

Telephone Percentages

A recent calculation as to the average number of people to every telephone places Chicago and Albany in the lead with 6.1 people to a telephone. Los Angeles is next with 6.8, followed by Washington with 7.2 and Detroit with 7.8. Boston has 8.4, New York 8.5 and Philadelphia 11.5. Jersey City showed the least development, with one telephone to every 23.8 people. Other cities are as follows: St. Louis, 12.7; Pittsburgh, 11.5; Cleveland, 11.9; Newark, 15.6; Buffalo, 12.3; Providence, 10.1, and Rochester, 16.1, while the average of all these cities was 11.2.

Effect of War on England's Wires

Annual Report of the Postmaster-General of Great Britain

IT IS stated 68,000 Post Office employes had joined the British colors by November 1, 1916. The whole of the personnel of the Army Post Office has been supplied by the Post Office and a large contribution has been made to the staff of the signal companies (R. E.), to the Naval Signal Units, etc.

The increased telegraph rates produced nearly $1,000,000 for the period from November 1, 1915, to March 31, 1916, against an estimate of $850,000, but owing to the paper restrictions, etc., the introduction of the new rates for press telegrams has been postponed until January 1, 1918.

Up to the end of March individual notice of the increased telephone rental had been given to 66 per cent of the existing flat rate subscribers, and in only 2 per cent of the cases dealt with was the service given up; 89 per cent of the subscribers whose replies had been received agreed to continue at the increased rental and 9 per cent decided to transfer to the measured service. It was calculatd that the increase in the trunk call charges would produce $1,450,000 in a full year and $600,000 in the six remaining months of 1915-16. The actual yield amounted to only $400,000, owing to the reduction in trunk line traffic being unexpectedly large. It is difficult at present to gauge the extent to which the fall is due to the increased tariff as distinct from other causes, *e. g.*, the reaction of the war on business, and it may be that trunk traffic will recover when these causes cease to operate. The increase in the charges for calls from public call offices by 2 cents was estimated to produce $700,000 per annum. The increased receipts for 1915-16 were estimated at $300,000, but only $50,000 was realized. Advantage was taken of the increase in the flat rates to determine all contracts at obsolete measured and message rates. This will not result in a large increase in revenue, but will simplify and unify the system of accounting and will thereby effect considerable economy in clerical work.

TELEGRAPHS AND TELEPHONES.

On March 31, 1916, the total mileage of post office wires (including spare wires) was 3,264,822 miles, an increase during the year of 192,955 miles or 6.3 per cent. The total mileage is allocated as follows: Telegraphs 264,480 miles of single wire, telephones 2,843,254 miles, spare 157,088 miles. Of the above 1,022,036 miles of single wire are aerial, 2,229,055 miles are underground and 13,731 miles are submarine. The storm at the end of March, 1916, was the worst in the history of the telegraph and telephone services. Gales were preceded and accompanied by heavy falls of snow and freezing rain, which, besides blocking up the roads to a depth of several feet, formed tubes of ice and snow, several inches in diameter, on the wires, thus greatly increasing the surface area upon which wind pressure was exerted. The wind was northeast and the path of greatest violence was along a belt of country bounded on the north by a line from the Humber to Pembroke and on the south by a line from the Wash to the Bristol Channel. Every telegraph and telephone line crossing this belt in a northern and southern direction was blown over and many of the poles and fittings were smashed. In this area 2,150 poles were broken, 6,050 were uprooted, and 33,300 blown over. This involved the re-erection of 41,500 poles, equivalent to 14,000 miles of main pole line, and about 1,500 tons, or more than 17,000 miles, of copper wire were broken into small lengths which had to be collected for re-manufacture. The repair of this damage would have taxed the resources of the department to the utmost even if the normal engineering staff had been available, but at present about half the staff is serving with the colors and in spite of the valuable assistance rendered by the military authorities, the work of repair was unavoidably protracted over many months. Railway telegraph lines also suffered severely and wire and other stores for repair purposes were supplied by the post office to some of the railway companies.

War Measures and the Telegraph Service.—The war has continued to make great demands upon the telegraph service. A large number of special circuits have been provided for the war office, admiralty and other government departments and there has been a constant call for skilled telegraphists for the army and navy. The number of telegrams sent on behalf of government departments has almost doubled during 1915-16 and special measures have been necessary to cope with this traffic. A few offices have been closed, the attendance for telegraph business at most offices has been curtailed and other measures taken. The number of telegraph offices open on March 31, 1916, was 14,156 (including offices at railway stations, etc.), against 14,222 last year, a decrease of 66.

Effect of War and of New Tariff.—There has been a large decrease in the number of paid telegrams sent during the year, but the revenue shows a substantial increase, chiefly owing to the higher rate of charge. The decrease in the ordinary inland telegraph traffic was 10.4 per cent, but government telegrams numbered almost twice as many as last year's return. The average length of a government telegram is almost twice that of an ordinary inland telegram and therefore the traffic passing over the telegraph lines during the year was not substantially less than formerly. The fall in ordinary inland telegrams is no doubt in part due to the increased charge, but other factors, such as the restriction of commercial and social activities, contributed to the falling off. Similar causes resulted in a decrease in the number of press telegrams of about 17 per cent compared with last year, and of about 12 per cent compared with 1913-14. There has been increasing difficulty in providing for the prompt treatments of telegrams by reason of the withdrawal of telegraphists for military service. Additional operators have been trained, telephone transmission has been resorted to where telephone circuits were not being used to their full capacity, and the use of high-speed apparatus has been extended. Referring to the work of the committee appointed in January, 1914, to consider the various systems of high-speed telegraphy, it is stated that the necessity for limiting capital expenditure and the general employment of manufacturers on munition work have caused considerable difficulty in the development of the use of machine telegraphs. A set of Murray multiplex apparatus was ordered early in 1915, but is not yet available for trial. The Murray system is so arranged as to allow eight separate messages to be signaled over one wire by means of transmitters fitted with type keyboards, which can easily be worked by ordinary typists after a short period of training. The messages are received in printed form. The number of Creed re-perforators and printers used on Wheatstone automatic circuits has been considerably increased. By means of this apparatus, telegrams transmitted at a very high rate of speed are received in the form of perforated slips, which can be used either in connection with a mechanical printing apparatus to prepare the telegrams for delivery or for further automatic transmission of the telegrams over Wheatstone circuits. Additional use has also been made of the Baudot multiplex system, by means of which as many as 8, 10, or even 12 messages may be telegraphed simultaneously through the one wire. The messages are printed on tape at the receiving end. Good use has also been made of a set of Western Electric apparatus, which embodies to a considerable extent the features of the Baudot and the Murray systems and allows of eight messages being transmitted simultaneously on one wire. The substitution of telephone apparatus for the Morse sounder at the smaller telegraph offices has been continued, thus facilitating the release of skilled telegraphists for service with the colors. The decline in commercial activity and the restrictions placed upon the use of registered addresses by the censor have caused a decrease of nearly 4 per cent in the number of such addresses. Four thousand four hundred and fifty-one new addresses were registered and 7,396 addresses were cancelled and the present total is 78,601 against 81,546 last year. During the year about $5,000 has been spent in improving the coast communication system by means of which information is furnished to lifeboat authorities of vessels shipwrecked or in distress. The system has been extended to 37 new watch huts provided by the Board of Trade for men who are on the watch for distress signals on parts of the coast not ordinarily under observation by the coastguards. Foreign telegrams show a substantial decrease as compared with last year, partly owing to the fact that last year's figures covered only eight months of war and partly owing to the further curtailment of commerce with Holland, Norway and Switzerland, and the cessation of business relations with Belgium. But while the number of telegrams has dropped, the words per telegram has increased.

Wireless Telegraphy.—The prohibition of the private use of wireless telegraphy has been maintained, and effective measures to enforce this prohibition have been taken under the defense of the realm regulations. All existing private stations, except a few required for government work have been dismantled; and the

apparatus has been taken into post office custody for the period of the war. The use of the coast stations for private radio-telegrams has been suspended until further notice. They are reserved for government purposes and for the exchange of necessary messages between merchant ships and the owners or agents.

Telephones.—The development of the telephone system in the United Kingdom, in common with other services requiring heavy capital outlay, was seriously retarded during the year ended March 31, 1916, owing both to want of funds and shortage of labor. The efficiency of the service has been well maintained, notwithstanding the release of many of the engineering staff for military service, and the exceptional demands made upon those remaining in connection with war work in this country. New orders for 43,286 telephones were accepted during the year and in addition over 5,000 circuits were provided for the naval and military authorities and the government departments. Many more applications for new telephones were received than could possibly be dealt with by the depleted engineering staff. It was decided in September, 1915, to impose a war surcharge, the minimum payment being fixed at $20, on all new telephone services with a view to limit applications to persons and firms urgently in need of that facility. The surcharge has had the effect of reducing the applications by approximately 50 per cent, and it has brought in $225,000 in the seven months ended March 31, 1916. Notices to remove 54,680 telephones were received during the year from subscribers giving up the service, compared with 52,584 in 1914-15. The number of telephones owned by the post office and in use on March 31, 1916 (exclusive of more than 15,000 provided specially for the temporary use of the naval and military authorities and of gevernment departments), numbered 786,991, made up as follows:

	Exchange Stations.	Private Wire Stations.	Total.
London	249,606	13,529	263,135
Provinces:			
England and Wales	382,458	23,889	406,347
Scotlad	86,063	5,158	91,221
Ireland	23,693	2,595	26,288
United Kingdom	741,820	45,171	786,991

The post office maintained in addition 2,236 telephones owned by subscribers. It is estimated that during the year, 776,000,000 effective calls were originated, a decrease of 4.8 per cent compared with the previous year. The reduction is due firstly to a decrease in the total number of telephones in use, secondly to a general economy in the use of the telephone by existing subscribers, and thirdly to the increase in charges already referred to. The average calling rate dropped from 2.97 calls per telephone per day in 1914-15 to 2.86 in 1915-16. The reduction in inland trunk traffic is not nearly so marked as the reduction in local exchange traffic. This is largely due to the exceptional increase in the number of long distance calls made on behalf of the naval and military authorities and of government departments. The total number of inland trunk calls in the year was 40,357,284, or 0.56 per cent less than in 1914-15. The increase in the charges for trunk calls resulted in a falling off in the use of the trunk service, but for this trunk traffic would have been maintained at the level of the previous year. Seventy-one new exchanges were opened, 46 in England and Wales, 6 in Scotland and 19 in Ireland, and these brought the total number of exchanges open on March 31, 1916, to 3,109. Seven hundred and fifty-one public call offices were opened and 991 were closed chiefly on grounds of public economy. Of the 751 call offices opened, 497 were provided with full trunk facilities, 45 with restricted trunk facilities, and 209 were for local service only.

Development of Trunk System.—During the year the number of exchanges connected directly with the general trunk system was increased by 74; and 126 additional trunk circuits were completed, involving an addition of 31,971 miles of wire (exclusive of spare wires). The improvement of the trunk service by the amalgamation of trunk and local exchanges has been carried a step further, the trunk and local exchanges in 15 more towns having been combined during the year with the result that in only 68 towns are there now separate local and trunk exchanges compared with 293 at the time of the transfer of the National Telephone Company's undertaking in 1912. Owing to financial and other difficulties arising out of the war, not much progress has been possible in the provision of additional trunk lines, but two important underground telephone cables have been completed. The London and Birmingham cable was extended to Liverpool and was opened for public service at the beginning of March last and a new cable between London and Brighton was brought into use in February, 1916. Considerable progress has been made in the acceleration of short distance trunk services, especially between Birmingham and Wolverhampton and Bristol and Bath. It is hoped shortly to introduce a similar service between Glasgow and Edinburgh, Glasgow and Paisley, Birmingham and Coventry, Dudley and Walsall, and between Manchester and Ashton-under-Lyne.

Automatic Exchanges.—Automatic telephone exchanges already installed at the general post office (London), Accrington, Chepstow, Darlington, Epsom, Hereford and Newport (Mon.) continue to give a satisfactory service. Difficulties caused by the war have delayed the construction of similar exchanges at Leeds, Grimsby and Stockport. It has, however, been possible to proceed with the work at Portsmouth, and automatic working was introduced there shortly after the close of the financial year.

Continuous Telephone Service, etc.—During the year a continuous telephone service was introduced at 23 exchanges where previously the service had been restricted; and the number of exchanges which are at present without a continuous service has thus been reduced to 334 out of a total of 3,109 exchanges. Continuous service has also been provided temporarily at many rural call offices and small exchanges, to enable the naval and military authorities and the police to obtain, in addition to telephone communication, direct connection at any hour of the night with important telegraph offies. During the year there was a net addition of 133 stations of rural party lines (farmers' lines), the number working on March 31, 1916, being 2,398. The Anglo-Continental services have been suspended for ordinary commercial traffic since the beginning of the war.

Conditions of Florida Merger

At a special meeting of the city commissioners of Daytona, Fla., April 10, a resolution fixing the rates of the Southern Bell Telephone Company on the system which the company is about to take over from the local East Florida Telephone Company was passed.

The agreement requires that within eight months after the Bell company takes over the lines, it shall begin work of reconstructing by putting in full, metallic circuits and other necessary facilities, and to make the whole thing a common battery, central energy, and an efficient telephone system.

The rates to be asked while the circuit is less than 1,000 stations, range downward from the special business line, which is $4.00 per month, to the four party telephone at $2.00. Parties having the telephone for a period of three months or less will be charged for a special line $25.50 down to a four party line at $13.50, and after the three months will pay monthly rates.

After the number of stations is above 1,000, the monthly rates are raised each a half dollar and the rates for the three months periods are to be raised three dollars.

When the number of stations exceeds 1,500 the rates are to be no higher than those charged by the Bell company in other towns of the state where it has systems.

The foregoing rates cover local connections with Daytona Beach, Daytona, Holly Hill, Seabreeze and Ormond, excepting all toll stations.

From the time that the Bell company takes over the lines until the reconstruction work is complete, service shall be charged for at the same rate as it now is.

Ask Guards for Big Toll Junction

The Central Union Telephone Company has asked for guards at the switching tower at Phoneton, Ohio, as lines to practically all parts of the United States pass through this point and its destruction would cripple telephonic communication throughout the state. Wires to New York, Chicago and St. Louis center there. Engineers have worked out emergency routes, which will be used in case switching towers are put out of commission.

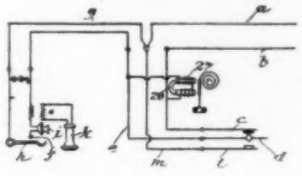
Telephone Patents Issued Recently

A Brief Digest of those Current Specifications Most Interesting to Telephone Men

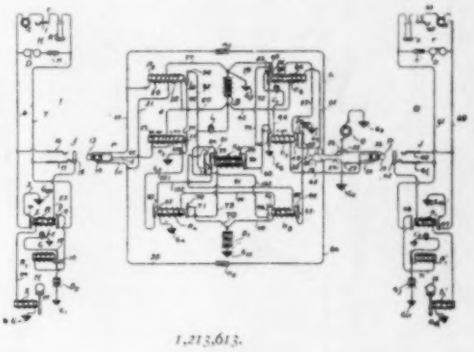
BY DAVID S. HULFISH

NOS. 1,213,613, 1,213,614, 1,213,615 and 1,215,616. Recording Sound by Means of Light and Photography. Issued to C. E. Fritts, assignor to J. D. Myers, Philadelphia, Pa. (Original applications filed October 22, 1880, and pending in the patent office for more than thirty-six years.) A photographic tape is used, and a sound record is made upon it by devices which may be compared to the oscillagraph. No. 1,213,616 shows a

1,214,694.



1,213,837.



1,213,613.

circuit for translating the record back into sound by the use of selenium and a telephone receiver.

1,213,837. Signal Device. Issued to A. E. Case, Chicago, Ill. For transmitting an auxiliary signal, as from a coin-collecting box, an armature is mounted upon a spring which vibrates it at audible speeds, and an electromagnet has its core near the armature and has its winding included in the telephone line while the signal is being sent.

1,214,466. Register. Issued to E. T. Hull, New York, N. Y. The object desired is to oblige the telephone user to register each call made upon the telephone. When the receiver is hung upon the hook a buzzer circuit is closed, and to stop the buzzer the register must be operated.

1,214,492. Automatic System. Issued to A. H. Dyson, assignor to Kellogg Switchboard & Supply Company, Chicago, Ill. (Application filed April 6, 1906.) The system is full automatic. Specific release circuits and battery feed circuits are claimed, including a repeating coil as the link between the two connected lines.

1,214,511. Timing Device. Issued to H. P. Clausen, assignor to Western Electric Company, Inc., New York, N. Y. A step-by-step timing device is started in connection with a cord pair when two lines are connected, and signals are given to the operator at regular intervals afterward.

1,214,512. Call-Distributing System. Issued to H. P. Clausen, assignor to Western Electric Company, Inc., New York, N. Y. When a line lamp is unanswered during a predetermined delay period, a timing device operates to switch the line to another operator's position. An automatic switch is shown for the means of switching the line to the new operator.

1,214,610. Receiver. Issued to Naho Tannaka, New York, N. Y. The receiver diaphragm has a yielding member, such as a pillar of soft rubber, pressing upon the center.

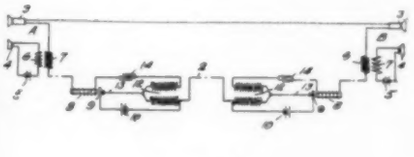
1,214,638. Selective Lockout System. Issued to F. W. Adsit, assignor to Adsit General Electric Company, Minneapolis, Minn. A step-by-step device at each telephone of a party line is operated by alternating current sent by the central-office calling device; the device at the central office is arranged to be set for each station of the line to send just the proper number of alternations of current to the selector. The call-bell then is connected to the selector and is rung over an earth circuit.

1,214,686. Supervisory System. Issued to A. E. Keith, assignor to Automatic Electric Company, Chicago, Ill. (Application filed May 14, 1907.) In an automatic exchange, each first-selector has a jack for manual supervision, and a signal lamp; the signal lamp glows while the selector is in its operating positions.

1,214,694. Meter System. Issued to A. D. T. Libby, assignor to Stromberg-Carlson Telephone Manufacturing Company, Rochester, N. Y. In a manual switchboard a meter is arranged upon each line at the central office and a relay is arranged upon each cord pair, the relay being operated at the close of the conversation and in turn causing the operation of the meter or call couter upon the calling telephone line; a second relay operates and locks to prevent double operation of the meter.

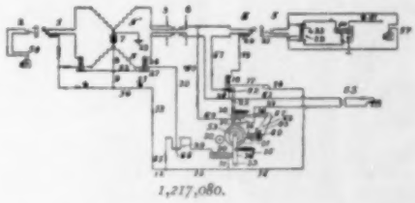
1,214,982. Automatic Telephone System. Issued to C. S. Winston, assignor to Kellogg Switchboard & Supply Company, Chicago, Ill. (Application filed April 11, 1910.) Each line has a small line switch to pick up a trunk to first selector. A quick relay for the first selector controls all of the selectors for selection, each selector having a slow relay individual to that selector. The release of all selectors is dependent upon a slow relay.

1,215,038. Repeater Line Circuit. Issued to C. D. Lanning and S. C. Drew, assignors to C. D. Lanning, Boston, Mass. (Application filed May 17, 1907.) In the telephone line circuit, one wire is unmodified and the repeating devices are included in the remaining wire of the line.



1,215,038.

1,215,348.



1,217,080.

1,215,331. Toll Signal. Issued to H. M. Bascom, assignor to American Telephone & Telegraph Company, New York, N. Y. A coin-collecting device at the telephone operates a signal device at the central office. At the will of the operator, the signal at the central office may be changed to operate differently, the object being to try to detect any effort on the part of the telephone user to obtain service without proper payment through manipulation or substitution of the coin-collector signal circuit.

1,215,348. Repeater. Issued to J. H. Cuntz, Hoboken, N. J. (Application filed February 13, 1903.) In an induc-

tion coil, a local battery circuit is used for providing a field magnetization of the core of the coil.

1,215,702. Loading Lines. Issued to H. B. M. Pleijel and A. H. Olsson, Stockholm, Sweden. Duplicate or phantom telephone lines worked on the Pupin system, loaded with induction coils wherein the coils of the main line consist of separate windings on separate iron cores laid together and so connected electrically that the phantom line becomes loaded by the stray fields created between the separate coils by the current in the phantom line; each loading coil consists of two double coils.

1,215,814. Automatic Switch. Issued to W. Kaisling, assignor to Kellogg Switchboard & Supply Company, Chicago, Ill. (Application filed April 27, 1910.) A flat contact bank is used. The movable brushes are lifted to the desired level by the rotation of a shaft and then are advanced to the desired tags by the rotation of another shaft.

1,215,859 and 1,215,860. Automatic Switch. Issued to J. N. Reynolds, asignor to Western Electric Company, Inc., New York, N. Y. The switch frame is filled with vertical and horizontal bars, trunk bars running in one direction and line bars in the other. Contacts connected to trunk circuits are carried by the trunk bars, and contacts attached to line conductors are carried by the line bars. The bars are shiftable endwise. By shifting a trunk bar its contacts are brought into the path of the line contacts, and by shifting a line bar its contacts are made to engage the trunk contacts of the shifted trunk bar but not those of any other trunk bar. One line thus is connected to one trunk.

1,215,911. Call-Distributing System. Issued to H. P. Clausen, assignor to Western Electric Company, Inc., New York, N. Y. A call is passed to a manual operator by an automatic switch; the automatic switch has two release relays, one of which is controlled by the subscriber's hookswitch and the other of which is controlled by the operator's cord pair.

1,215,925. Automatic System. Issued to C. L. Goodrum, assignor to Western Electric Company, Inc., New York, N. Y. The feature of the novelty is that one of the relays for feeding current to the called line is used as a busy test relay for completing the connection when the selected line has been found idle.

1,216,136. Repeater. Issued to B. W. Kendall, assignor to Western Electric Company, Inc., New York, N. Y. To cite the language of the patent claims, the telephone line has a bridge composed of resistance and capacity in multiple, and the telephone repeater is connected as a shunt upon a portion only of that bridge.

1,216,323. Call-sender. Issued to A. E. Keith, assignor to Automatic Electric Company, Chicago, Ill. (Application filed August 7, 1907.) A ratchet wheel of insulating material operates the signaling contact springs. This transmits the vertical impulses for the three-wire Strowger system, and a separate wheel transmits the rotary impulse which follows every set of vertical impulses.

1,216,365. Trunk Repeater System. Issued to C. E. Rogers, assignor to Automatic Electric Company, Chicago, Ill. In a trunk repeater device for repeating the signals of an automatic call-sender from the calling line to the trunk, the circuits transmit one class of signal impulses directly over repeat all signals of another class.

1,216,461. Reverting Call System for Automatic Telephone Exchanges. Issued to G. E. Kimball, assignor to Automatic Electric Company, Chicago, Ill. (Application filed June 23, 1909.) The result desired is to enable a telephone upon a party line in an automatic exchange to call another station upon the same party line and to ring the bell of the station to be called. This is accomplished in the patent by an arrangement of slow-acting relays having different time intervals for operation.

1,216,534. Emergency Supervisory System. Issued to G. A. Yanochowski and H. E. Hershey, assignors to Automatic Electric Company, Chicago, Ill. In an automatic exchange, signal means is provided for signaling to a manual operator in case a selector strikes an open trunk or a connector strikes an open line circuit.

1,216,641. Change-over System. Issued to C. S. Winston, assignor to Kellogg Switchboard & Supply Company, Chicago, Ill. A system for controlling the operation of automatic switches, in which a metallic line circuit is used for sending the directory impulses or "vertical" impulses, and in which a differential relay is used for the change-over impulse or "rotary" impulse.

1,216,844. Supervisory System. Issued to J. G. Roberts, assignor to Western Electric Company, Inc., New York, N. Y. A system for controlling an operator's lamp signal over circuits which include automatic switches and subscribers' lines.

1,217,080. Time Limit System. Issued to F. W. Adsit, assignor to Adsit Genertal Electric Company, Minneapolis, Minn. A timing device (a ratchet device driven by electric impulses is shown) is connected in the cord pair of a manual switchboard and operates to cut off the connection between the two lines at the end of the time period for which the device is adjusted.

1,217,081. Lockout System. Issued to F. W. Adsit, assignor to Adsit General Electric Company, Minneapolis, Minn. In working a party line having lockout devices, the inventor encounters the problem of connecting for conversation two telephones upon the same line, because the first telephone upon the line locks out the other telephone. This is the problem which is solved by patent No. 2,217,081. When two receivers are lifted upon a common battery line, the operator at the central office by cutting off the battery momentarily will permit both telephones to connect to the line for conversation.

1,217,121. Line Switch. Issued to A. E. Keith, assignor to Automatic Electric Company, Chicago, Ill. (Application filed May 14, 1907.) In a tripping line switch for automatic exchange working, two tripping magnets are provided, one to be operated when the telephone line originates a call and the other to be used when the telephone line is called.

Will Use Transcontinental Line

Arrangements are being made by the war department at Washington, together with the western department, for the use of the 3,000-mile long-distance telephone circuits of the Pacific Telephone and Telegraph Company, which link in the Atlantic with the Pacific coast with the longest overland long-distance telephone wire in the world.

Special arrangements have been made with the telephone interests whereby this wire is to be used by the government for telegraphic purposes in the transmission of government code messages and the transmission of private business. The wire is to be protected from interference for every mile of the distance by company and army patrols and will insure direct communication between Washington and the Presidio in San Francisco, as well as the Mare Island navy yard.

Under the present system of communication, the only direct link between the two coasts devoted solely to federal use is the overland wireless system of two private companies and the great station at Mare Island and Point Loma. These two stations are in direct communication at all times with the big Atlantic coast station at Arlington, New York, and if necessary with Tuckerton, New Jersey, which are among the biggest radio equipments in the world. In addition, the giant station of the Marconi company at Bolinas bay will be available.

With the addition of the wire service between the two coasts direct communication can be assured by a double channel. In order to insure the satisfactory operation of the wire, employes of the telephone company are to be taken into government service for line troubles and other necessary mechanical details.

To still further facilitate the communication between the two coasts, nearly a hundred men from the Postal and Western Union telegraph companies on this coast, numbered among the most expert operators in the business, are to be taken into the government service for the rapid handling of government business. The completion of these plans, which it is understood will have been reached within the next few days, will give a complete and almost unequalled line of communication between the two coasts by telegraph, telephone and wireless.

Public Utility Commission News

Reports Concerning the Activities of State Regulating Bodies in the Telephone Field

Pennsylvania

THE Public Service Commission in an order issued April 5, directs a state-wide readjustment in the rates of the Bell Telephone Company, which it is estimated at the office of the commission will mean $1,000,000 a year to the public.

The order will bring the largest reduction made in telephone charges by any commission in the country and estbalishes the important principle that the telephone company's properties must be considered as state-wide instead of on a segregated basis. It will also mean a reduction in long distance telephone charges which will take some time to work out. The decision was announced after a conference with the counsel for the telephone company.

The order means an annual reduction of big sums in the large cities. Estimates are:

Philadelphia, $450,000.

Pittsburgh, $300,000.

Toll rates, $250.00.

The effect of the commission is to approve measured service for business purposes as opposed to unlimited service rates in the larger cities.

The ordere is as follows:

On November 21, 1913, the public telephone companies in the state of Pennsylvania which eventuated in the investigation of the Bell Telephone Company of Pennsylvania and the Central District Telephone Company. The Pittsburgh Chamber of Commerce and Service Commission, on its own initiative, started an investigation of the two telephone companies which were parties to the investigation in which a large amount of evidence was presented.

The telephone companes affected by this proceeding operate in all parts of this commonwealth and supply a general and comprehensive telephone service. These companies supply a general telephone service within this commonwealth and reach with their lines practically all places within the commonwealth and connect with other companies, which reach all points and thereby the people within the range of telephonic communication, as far as it can be obtained.

These telephone companies are incorporated to do a general telephone business throughout the state and one of the important questions presented is whether the revenue, expenses and operation of these companies should be treated from a local or from a state-wide standpoint. If we are to have a comprehensive telephone service in the commonwealth, it is advantageous that such service should be rendered by companies under one control, and that such companies should receive the benefits of being treated as to revenue and expenses from a state-wide and not from a segregated or local standpoint.

It the segregated theory is to be adopted there will necessarily result a construction of telephone development in the state by reason of the companies refusing to develop the unprofitable places. In order to provide for a comprehensive development it seems necessary to have the companies' operations as to service and rates considered from the standpoint of their revenue and expenses as a whole, and if they are found to be reasonable, then an equitable distribution of the burden of the charges can be made between the various communities. The Public Service Commission of New Jersey, Maryland and Colorado have accepted this state-wide principle.

In carrying out this plan for a comprehensive and general development of the telephone service a relationship has been established with the American Telephone and Telegraph Company, which performs services, supplies certain types of apparatus, and aids in patent litigation and in financing. All the evidence indicates that these services are valuable and this relationship conduces to the best interest of telephone users and of the telephone companies, and there is no evidence in this case which shows that the payment for this service is unreasonable or excessive.

The question of the readjustment of the rates in Philadelphia and Pittsburgh, and the readjustment of the whole rate schedule has been taken up and discussed with the companies and with the Chamber of Commerce and representatives of the council of the city of Pittsburgh. We are of the opinion that a reduction of the revenue should be brought about by a readjustment of the schedule of rates in Pittsburgh and Philadelphia and the toll rates, which will amount in the aggregate to one million dollars annually.

The amount of the reduction in rates in Pittsburgh will be approximately $300,000; in Philadelphia, $450,000, and of the toll rates approximately $250,000. This reduction, of course, is based upon the present business of the companies.

The telephone companies are therefore directed to file schedules of exchange rates for Pittsburgh and Philadelphia and toll rates for the state, to go into effect on the dates thereon indicated, which will produce a reduction of revenue of one million dollars annually. The revised exchange and toll rates with the existing rates for other places and other classes of service now in force and effect and on file with this commission shall be the maximum rates to be charged by these companies and shall continue for a period of three years from the date at which they become effective and until the further order of the commission. The evidence produced in this case shall not be used as evidence in any case involving the question of rates in the state of Pennsylvania during the above period of three years.

The inhibitions in the law against discrimination apply as well to the classification of subscribers in the same locality as the classification as between localities. And in this connection we approve the general principles of the measured system of charging for business service which these Bell companies now have in effect in Philadelphia and Pittsburgh, under which each subscriber pays according to the actual number of messages he sends, instead of a flat system of charging under which all subscribers would pay the same flat rate or sum per annum irrespective of their actual usage.

It appears in the evidence here, as seems almost obvious, that in large cities such as Philadelphia and Pittsburgh, there is a wide variation in the use which business subscribers made of the telephone, so that the inevitable result of charging the same flat sum per annum to each subscriber would be a benefit to the relatively few large users and a detriment to the many who have need for and, in fact, do use relatively few messages. Furthermore, actual experience in Philadelphia and Pittsburgh, as well as in other large cities in the United States, has shown that the measured system of charging, whereby each subscriber pays only for his actual use, tends to more rapid development of the use of the telephone and thus enables the telephone companies to fulfill one of the prime duties of public service corporations, namely, to extend their services to as large a portion of the public as is commercially possible.

For example, under the old flat rate plan, which obtained in Pittsburgh, each business subscriber paid $125 per annum, whereas under the existing measured schedule in Pittsburgh the average amount paid by business subscribers is very much less than $125, so that the result has been to extend the service to a large number of business men who did not have to send a large number of messages per year and who could not afford to and would not pay the sum of $125 per year.

The rate schedules now on file with this commission by the telephone companies and produced in evidence in this case do not provide for a continuation of the business flat rate contracts in Philadelphia and Pittsburgh. Whereas, as a matter of fact, out of the 72,000 business subscribers in Pittsburgh there are about 2,700 still receiving business service under old flat rate contracts.

The situation, therefore, resolves itself to this—that the telephone companies have allowed a continuation of existing flat rate contracts but refuse to allow new subscribers the same privilege. This constitutes a discrimination as between the subscribers, and we are therefore of the opinion that the existing flat rate contracts should be eliminated and all subscribers should be treated alike.

The Central District Telephone Company is ordered by the commission, February 6, to continue rendering service to and from the central office maintained by the estate of W. J. Rainey, Uniontown, Penna. The commission says:

February 20, 1908, the Central District Telephone Company

(a subsidiary of the Bell Telephone Company of Pennsylvania), entered into a contract with complainant whereby the entire private telephone system of complainant, constructed and operated by complainant so as to connect and communicate with its various coke plants, was connected with the Central Company through the private switchboard of complainant by means of two trunk lines, thereby affording direct service from any point on the Central System to any of said coke plants, and vice versa. A similar arrangement was in force with the Tri-State Telephone Company. However, there was no interchange of service between it and the Central Company by means of the private switchboard, although such was possible. May 16th, 1916, the Central Company announced it would discontinue the service on the ground that said contract was not in accord with its rates and regulations offered to subscribers under similar circumstances and conditions and set forth in its tariffs; that the contract was discriminatory and preferential and in violation of the Public Service Company Law. The company refused to resume service except on a basis of absolute ownership of the entire equipment of complainant.

Complainant protested against such discontinuance of service. Commission held that this is not a case where the complainant is endeavoring to compel a telephone company to connect its service with a privately owned and installed system. It is a case where the complainant is resisting an effort on the part of the telephone company, to discontinue a service which has been rendered for years in pursuance of a contract on the strength of which complainant enlarged and improved its system. There has not been and is not now any claim that it is inefficient or departs in any way from the standard equipment now used by the company. It is one thing to require a telephone company to enter upon the furnishing of service by means of privately owned and controlled equipment, and quite a different thing to prevent it from discontinuing service by means of such equipment under circumstances similar to this case. Likewise the rules and regulations now proposed to be enforced were in force when the contract was entered into and have remained in force ever since. Thus, under all the circumstances, the company's interpretation of its rules and regulations as applicable to this case are unfounded, and it is unreasonable and unjust for it to refuse service except under conditions of absolute ownership of the facilities of complainant by the Central Company.

The Commission has ordered, February 7, that a certificate of public convenience be issued evidencing the commission's approval of the Farmers' Mutual Telephone Company of McKean County's contract with the Borough of Middleboro, Penna. The commission says:

The Farmers' Mutual Telephone Company was incorporated to do a telephone business in the Borough of Middleboro, Erie County, and in other designated territory. It secured from the Public Service Commission a certificate of public convenience approving its incorporation. By means of a mandamus it secured an ordinance from the borough permitting it to use and occupy the streets. This ordinance came before the Commission for approval. The McKean Independent Telephone Association filed a protest against the approval of the same, inasmuch as it was serving said borough adequately and was willing and ready to establish a physical connection with the lines of the Farmers' Mutual Telephone Company outside the borough, thereby rendering all the service necessary. It likewise had long-distance service over the lines of the Bell Telephone Company which it was willing to offer.

The Commission held that in the application for approval of its incorporation the proposed service to the borough of Middleboro was in specific terms before the Commission. In approving the incorporation the Commission approved of the right to construct telephone lines in said borough, therefore, the Commission has once passed upon the question of public necessity and convenience. That approval was before the Court of Common Pleas of Erie County when the writ of mandamus issued. Therefore, the only question before the Commission is the reasonableness of the restrictions imposed by the borough ordinance, as it cannot approve or disapprove what is not before it. The reasonableness of the terms of the ordinance not being questioned, and as they appear to be fair and to properly safeguard the public interests, it should be approved.

The non-competitive rule is not one of law arbitrarily to be applied; it is a rule of regulatory policy. Its purpose is to secure to the public at the hands of public service companies a higher quality of and a more certain and permanent service, and at lower rates than ordinarily can be obtained under the waste of competition. It was not intended to entrench a utility company in monopolistic privilege except as thereby such company is prepared to furnish better service and at more reasonable rates than it otherwise could. It is not a rule primarily in the interest of the utility, but for the benefit of the public dependent upon that utility. Whenever the reason for the rule fails, the rule must fall. Like all regulatory policies it must stand or fall under the test imposed by the statute that utility companies must be prepared to render to the public such service as is necessary and proper for the accommodation, convenience and safety of the public. It having been shown that the McKean Independent Telephone Association could not serve the borough adequately, the Commission was clearly within its power when it approved the charter of the Mutual Company, thereby assuring proper and adequate service to the inhabitants of the borough.

The commission refused a certificate of public convenience to the Quaker Valley Telephone Company, allowing it to construct and operate a telephone system in Bedford county, Penna.

Illinois

The State Public Utilitties Commission of Illinois, April 18, ordered the Postal Telegraph Company to cease doing a telephone business until it receives a certificate of convenience and necessity from the commission. On complaint of the Chicago Telephone Company, the commission investigated the charge that the telegraph company was operating telephones between Chicago, Joliet, Peoria and other cities over its telegraph lines. The charter of the company gives it power to operate only a telegraph business, and for this reason the telephone system is declared illegal.

The city of Dixon will formally protest the increase in telephone rates by the Home Telephone Company, sanctioned by the state utilities commission. Complaint will be made that the new rates are exorbitant.

The Illinois public utilities commission has authorized the Chicago Telephone Company to issue $6,000,000 of its capital stock to pay for improvements made during the last two years.

Minnesota

The Railroad and Warehouse Commission of Minnesota has ordered, April 25, that the Watertown Telephone Company be permitted to purchase from the Northwestern Telephone Exchange Company, its local telephone exchange located at Delano, Minnesota, and its toll line extending between Delano and Watertown, Minnesota; also that all toll line and rural line connections now existing with the local exchanges of the petitioner and respondent, be continued after the consolidation.

Application having been filed by the Farmers' Telephone Company of Ellendale, Minnesota, for authority to purchase the telephone exchange at Ellendale, Minnesota, from the Ellendale Rural Telephone Company, in which it is alleged that the Ellendale company desires to sell this exchange for the reason that it is in the hands of an administrator of the estate of the late Grace McDonald, and must be sold to settle the estate, it is ordered that a hearing be held before the commission at its office in St. Paul on Tuesday, May 1, at 10:30 a. m.

Oklahoma

The Oklahoma Corporation Commission has dismissed the complaint of the Fort Supply Telephone and Telegraph Company against the Pioneer Telephone and Telegraph Company, in which the former complained

that the latter was making a rate so low as to force the complainant out of business. The policy of the commission as outlined in a former opinion, to the effect that t will not encourage multiplicity of telephone companies, was adhered to.

Kansas

The Kansas Public Utilities Commission, in authorizing the sale of the Parsons and Pittsburgh Independent telephone properties to the Bell interests, April 6, inserted a clause in the order authorizing the sale of the plants that is revolutionary in Kansas telephone experience. The Bell, under the order issued by the utilities commission, is required to make physical connection over all its lines with any telephone connected with local exchanges in Pittsburgh or Parsons.

Under this order any person who can get connection with Parsons can be connected directly with any point on the entire Bell telephone system. Physical connection must be made so the patron of the old Pittsburgh or Parsons Independent systems can talk direct anywhere on the Bell system. If the same system is applied over the entire state, it will mean that where there are rival telephone companies in a locality, they must furnish physical conections with rivals, and a patron of one system can talk to persons on competing systems as well.

West Virginia

Favorable action was taken by the public service commission on an application of the Chesapeake and Potomac Telephone Company, to file a new tariff lowering the telephone service rates 50 per cent on all state and federal government messages on matters connected with the prospective war, movement of troops and all preparedness matters.

Ohio

Following a brief hearing, the Ohio State Utilities Commission, in the case of T. R. Plank and others protesting against the Star Telephone Company of Ashland increasing rural party line rates from $1 to $1.35 per month has decided that the commission's rate expert shall make an investigation of the money actually invested by the company, as well as all receipts and expenditures. The proposed investigation is to determine whether excess earnings are being made and whether the increased rate is justified.

It is reported that the Ohio Public Utilities Commission has refused the Lima Telephone & Telegraph Company a new hearing in the recent rate decision. This means that the company has but one remaining way out, to carry the case to the supreme court on error.

Insofar as the rebate for two years ordered by the commission is concerned, it may be carried further. But the new rate is acceptable to the company, as shown by the fact that the new bills sent out on April 1 are made on the new schedule, a cut of $6 a year as ordered by the commission.

Idaho

The Public Utilities Commission of Idaho has ordered that the Telephone Service Company, Ltd., at Roberts, Jefferson county, be granted a certificate of public convenience and necessity to construct, own, operate and maintain a telephone system and telephone lines in the village of Roberts, Idaho, and the surrounding territory.

It is further ordered that the applicant file with the commission a statement showing the amount of purchase price paid to the Market Lake Telephone Company for the properties purchased and taken over by the applicant, and that it keep a detailed and accurate account of all expenditures made by it in the reconstruction and extension of its telephone system and lines.

National Service

The greatest opportunity for immediate service to the country that is now presented telephone companies is in assisting the Department of Agriculture in securing the attendance of farmers at the hundreds of meetings now being held in schoolhouses in every state for the purpose of urging the increased cultivation of food crops demanded by the war.

Telephone companies, by calling their rural subscribers and urging them to attend these meetings, can be of the greatest assistance. This is a patriotic duty no manager should neglect. Our facilities should be at the service of federal and state authorities. Let us be active in our co-operation—in doing a part no one else can do.

F. B. MACKINNON.

Chicago's New Telephone Building

Evidence of the rapid development of the telephone business in Chicago is seen in the construction by the Chicago Telephone Company of another large office building in the loop district. The company now occupies a twenty-story building at 212 West Washington street, which is one of the largest structures in the world devoted to telephone purposes. In addition, it has thirty-nine other office buildings scattered throughout the city.

The new addition to the telephone group is located at 311-15 West Washington street, diagonally across the street from the present general office building. It is to be eleven stories in height and the front elevation will be the Venetian Gothic style of architecture.

Work on the new building was commenced October 21, 1916, and the steel structure is now well under way. The building is of the court type, with a frontage of 135 feet on Washington street and a maximum depth of 180 feet. Each wing will be 43 feet wide. While the original plans provide for the construction of eleven stories, the foundation is such as to permit of the addition of more floors as they may be needed in the future.

The new office building will be used exclusively by the Chicago Telephone Company, and will house the new exchange unit which has been given the name of "Majestic." Ultimately it is planned to move all of the central office equipment for the loop district, which includes Main, Central, Franklin and Randolph, into the new building.

The eleventh floor of the building will be used for a dining room, which will be at the disposal of the company lunch clubs, choral and dramatic societies, and other organizations of employes, for luncheons and banquets. The dining room and kitchen facilities will be adequate to care for five hundred persons.

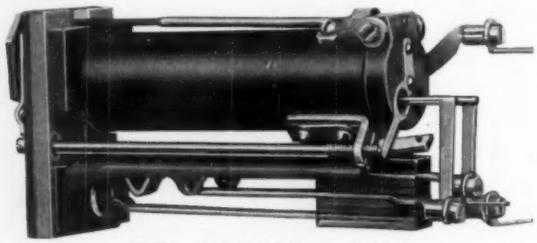
Of Interest to the Trade

What the Telephone and Accessory Manufacturers Are Doing to Advance the Art

Kellogg Combined Drops and Jacks

Most telephone men will recognize the illustration of the rear view of the well-known Kellogg combined drops and jacks, reproduced on this page.

The point upon which the company lays particular emphasis, however, is the easy opening up and separation of the night alarm contact, should it be necessary to get at the armature, or for any reason remove the individual



Kellogg Combined Drop and Jack.

drop. This, it is stated, can be very easily done with Kellogg combined drops and jacks, but a great many telephone men never think of it because it is almost never necessary.

Kellogg drops do not "burn out," as their record in thousands of exchanges throughout the country prove.

Endorse American Telegraph Invention

When the telegraph was first put to commercial use, only one message at a time was sent over each wire. This was adequate for the comparatively light demands made upon the telegraph at that time. But as its advantages for rapid communication became more fully appreciated, telegraph engineers developed the simplex and the duplex systems of circuits. This invention made possible the simultaneous sending of more than one message over the same wire.

In recent years there has been an ever-increasing demand on the telegraph service, not only in this country but also abroad. It was, therefore, required of the telegraph engineers to develop some device or system that would make possible a more intensified use of the telegraph wires.

After a thorough and patient investigation, and careful and scientific experiments, a modern multiplex printing telegraph was developed. America, as usual in the development of the telephone and telegraph, has taken the lead in this printing telegraph development work; and it is with no little interest that we note in a recent issue of our British contemporary, the *Electrical Review*, published in London, that a special committee appointed by the British postmaster general, have favorably endorsed the high-speed multiplex telegraph system designed and built by the Western Electric Company, Incorporated. This committee, which consisted of prominent post office officials and leading electrical engineers, were appointed at the beginning of 1914.

The committee arrived at its conclusion after a most painstaking investigation, and after having reviewed the merits of various telegraph systems that had been tried in the British provinces during the last decade. As a practical experiment during their study, a complete quadruple duplex installation of Western Electric Multiplex equipment was installed on a circuit between London and Manchester. It is quite interesting to know that the report of the committee states that this Yankee invention has handled at least two-thirds of the entire telegraphic traffic between London and Manchester over a single telegraph circuit. The *Electrical Review*, in summing up the leading conclusion of the committee, says in part: "Of the multiplex systems at present available, the Western Electric has given the best results."

Directory Gives Transmission Hints

A very plain and easily read directory is the latest guide of the Goreville Telephone Company, Goreville, Ill. The cover is an attractive green, and the names of the town and state appear under the name of the telephone company—a convenient detail which is missing in many directories.

The inside of the cover explains the rules and regulations briefly, but clearly, outlined.

As this book was issued at the first of the year, several paragraphs are of the Season's Greetings for 1917. They are addressed to all patrons and users of the Goreville Telephone Exchange and signed by W. S. Terry, manager. The back cover has the following helpful service information:

"I CAN'T HEAR YOU"

CAN BE "BLOTTED OUT" OF YOUR TELEPHONE SERVICE.

"You can improve your own telephone service. Many complaints that you do not hear, or that others do not hear you, are possibly due to the improper method of speaking into the transmitter. Telephone engineers after exhaustive tests have made the following conclusions and are the authority for the following statement:

"The best results are obtained with the lips very close to the transmitter, just so they do not touch it. Removing the lips from the transmitter has the same effect as lengthening the line in use as follows:

One inch lengthens the line	57 miles
Two inches lengthens the line	128 miles
Three inches lengthens the line	179 miles
Four inches lengthens the line	218 miles

"The telephone is now so common that it is naturally supposed nearly everybody knows how to use it correctly, but even the telephone men of long experience are surprised at the improvement in service made possible by a careful study of methods of speaking into the transmitter. Care in this matter will not only add to your satisfaction and pleasure but will boost the service. The illustrations on how to use the telephone and helps in bettering service conditions were furnished by the Kellogg Switchboard and Supply Company."

Mathias Klein Retires; Sons Continue

Mathias Klein, having attained the age of 90 years, retires from business and has transferred his interest in the firm of Mathias Klein & Sons to his sons, John M. Klein and Joseph A. Klein, who have always been associated with him and who will continue the business under the present title of Mathias Klein & Sons.

Stromberg's Silent Salesmen

Thirty thousand silent salesmen have been sent out to the trade by the Stromberg-Carlson Telephone Manufacturing Company of Rochester, New York. These salesmen will cover the country from coast to coast. They will never return to the sender because they have been instructed to stay on the job and sell something or else die in the attempt.

These silent salesmen are not real flesh and blood traveling men but bulletins describing and illustrating a complete line of equipment required in the construction and maintenance of a local battery telephone system. This bulletin is along the same general lines as the farmer line bulletin No. 1009 sent out by the company last year, except that it consists of more pages and contains illustrations and descriptions of many pieces of new apparatus developed during 1916.

If one of these silent salesmen has not reached your office you may get one started your way by dropping a line to the company's advertising department at Rochester, N. Y.

Western Electric's Arrangements

The Western Electric Company, by its president, H. B. Thayer, has issued the following statement to its employes:

MILITARY AND NAVAL SERVICE.

The telephone service of the Bell System is of the utmost importance to the military authorities and to the effective mobilization of the country's industries in preparation for war, and their conduct during war, if war occurs. To avoid crippling or impairing that system of communication and to meet the demands for increased service, and to provide the Army and Navy with such material as this company is qualified to supply, it is necessary that we should maintain an adequate and experienced personnel. True loyalty and patriotism will require of some of our people that they continue at their present work, rather than seek more direct military or naval service in the Government organizations.

The company has undertaken certain engagements with reference to members of the National Guard and Naval Militia called into service under the President's proclamation of June 18, 1916, and with reference to such employes as become members of the Signal Officers' Reserve Corps or Signal Corps Sections of the Enlisted Reserve Corps.

Employes of the company who were members of the National Guard or Naval Militia on the 18th of June, 1916, or who have since become members with the consent of the company, if now on active service or if called into active service by the Federal or State authorities, shall while on such service, up to and including June 30, 1917, receive from the company their full regular pay, less the pay they receive from the government for military service.

After completion of military or naval service, such employes will be given such employment as the needs of the company permit and as the employe is qualified to undertake.

Under the Employes' Benefit Plan such employes returning to work for the company after the completion of military service, shall be considered as having been continuously employed, but no benefits shall accrue to them during their absences.

As to future enlistments in military and naval organizations which may require absences from the company's employment, it is required that in order to receive benefits from the company the following procedure shall be observed:

1. An application for the company's approval of enlistment shall be made.

2. If it be found that such enlistment does not interfere with the company's ability to perform its duties to the country, permission to enlist shall be granted.

To only such as shall receive permission as above described and were in the employment of the company April 1, 1917, or during a period of one year before enlistment, will benefits be extended by the company. The benefits so extended will depend upon the merits of the case and will probably take the form of payments to dependents during military and naval service of employes and of re-employment after the completion of such service.

Bellefontaine Getting Ambitious

The board of directors of the United Telephone Company at Bellefontaine, Ohio, has completed specifications for bids for a new switchboard of the latest type for installation in the Bellefontaine plant. Bids for both manual and automatic plant will be considered. It expects to expend the sum of $10,000 for new cable construction.

The company announces a raise of rates of 25 cents over existing rates, effective July 1. This rate is absolutely necessary, the company claims. The present rates do not bring in sufficient revenue to pay the expense of traffic, replacement, depreciation and interest on investments. An audit of the books by an expert accountant has just been completed. The audit shows that the receipts for telephone rental for the last three years have not been sufficient to pay the actual expense. The loss during the past year has been heavy, since everything that enters into telephone property has advanced on an average of one hundred per cent. Wages have also advanced and will continue to go higher. The present switchboard is almost worn out and is now overloaded. At the present time there is not a drop left to take care of new subscribers. The company is going to considerable expense to install a temporary addition to take care of the public until the new board is in operation. The company subscribers in Bellefontaine appreciate conditions which call for new equipment and the consequent raise in rates.

Home Burned; Lives Around Pole

C. W. Rees, Tri-State Manager at Grand Forks, sends in the following story of an ingenious farmer who handles his emergency in a peculiar way.

"A few days ago," says Mr. Rees, "a report came into the office that the home of one of our rural subscribers, about nine miles from town, had been burned to the ground.

"I thought that before sending someone out there I'd find out if the line was still working, so I called, and was greatly surprised to hear the subscriber's voice in reply.

"'Sure I was burned out,' said the farmer, 'burned right to the ground, but I reached in through the window and pulled the telephone off the wall. I now have it nailed to your telephone pole, which I am using as a center pole for my tent.

"'I'd like to use it,' he added, 'until such time as I can rebuild.'"—*Our Emblem.*

Enjoy "Intolerable" Privileges

The last effort of the city of Des Moines, Iowa, to force the Iowa Telephone Company to apply for a franchise, which would have taxed the company $300,000 annually for the state of Iowa, failed, according to a decision handed down by the supreme court.

H. W. Byers, city's corporation counsel, pleads for legislation seeking to correct "intolerable" privileges allowed telephone companies by recent Supreme court decisions, in letters sent to members of the Des Moines delegation in the general assembly.

The letter refers particularly to the decision by which Des Moines lost $71,000 pole and wire tax. It cites that the practice, by this decision, is fixed in Iowa to be the opposite of the practice in a number of other States.

Brevities of the Business

The Activities of the Whole Telephone Field Told in Short Paragraphs

PERSONAL NOTES.

C. Y. McVey, president of the United States Independent Telephone Association, has been elected president of the Ohio State Telephone Company. He succeeds S. G. McMeen, who retires on account of ill health. Mr. McVey's first connection with the telephone field was in 1899 as general manager of the Youngstown Telephone Company. He later became general manager of the Cuyahoga Telephone Company, of Cleveland, which position he held until 1914, when that company was absorbed by the Ohio State Telephone Company. Mr. McVey was retained as general manager of the Cleveland district.

George R. Grant, assistant secretary of the New York Public Service Commission for four years, has been made general attorney for the New England Telephone and Telegraph Company, with headquarters in Boston. Since 1913 Mr. Grant has been associated with the legal staff of the New York Telephone Company, and has represented the New York Telephone Company, the Bell Telephone Company of Pennsylvania, and the Chesapeake and Potomac Telephone Company.

Paul S. Higman has been appointed the new manager for the Citizens' Telephone Company, of Kokomo, Indiana. He comes from Bedford, where for the last thirteen years he has been telephone manager.

Lloyd B. Wilson, of Omaha, Nebraska, special agent on the staff of the general commercial superintendent of the Nebraska Telephone Company, has been appointed commercial superintendent of the Northwestern Telephone Exchange Company, effective May 1, with headquarters in Minneapolis. Mr. Wilson will succeed M. L. Lane, of Minneapolis. Mr. Lane comes to Omaha as assistant general commercial superintendent of the Northwestern group of the Bell Telephone system, which includes both the Nebraska and Northwestern companies.

A. P. Wozencraft, advisory counsel of the Southwestern Telegraph and Telephone Company, who died suddenly in Arkansas, was a former adjutant general of Texas, with the rank of brigadier general, and for many years was identified with the Texas volunteer guard, now known as the Texas National Guard.

At the annual meeting of the committee on telephone accounts and statistics, representing the entire telephone industry—both independent and Bell—held at Chicago, LeRoy Parker, controller of the Ohio States Telephone Company, Columbus, was elected chairman for the ensuing year. This is a marked recognition, inasmuch as this commitee is composed of the most eminent telephone accounting authorities in the country, and bears the same relation with respect to telephone matters in connection with the Interstate Commerce Commission and other regulatory bodies, as does the American Railway Accounting Officers' Association, with respect to railroad matters.

James S. Russell, of the Chesapeake and Potomac Telephone Company, has been promoted to the office of plant wire chief at Salisbury, Maryland.

William J. Clark, city commissioner-elect at Grand Rapids, Michigan, resigned as a director of the Citizens' Telephone Company at a meeting of the board. No action was taken at that time to fill the vacancy.

B. Donovan, who has been manager of the Southern Bell Telephone Company's office at Ensley, Alabama, for several years, has been promoted to a position with the office at Birmingham. S. A. Berry will have charge of the local office for the present.

N. C. Upp, for several years manager of the Amherst Telephone Company of Ohio, resigned, to take effect May 1, having accepted a position with the Cleveland Telephone Company.

F. G. Ravorite, who has formerly been manager of the Chehalis, Washington, office of the Pacific Coast Telephone and Telegraph Company, has been promoted to manager of the Centralia district, and in the future will have charge of both the Centralia and Chehalis offices, succeeding Paul Bone.

Charles H. Townsend, for the past six years local manager of the New York Telephone Company, in Watertown, New York, has tendered his resignation, effective May 1. He will move to Chaumont, to take charge of the Township Telephone Company, which he recently purchased in conjunction with two or three other local men.

H. E. Owens, formerly manager of the Pacific Telephone and Telegraph Company, at Mill Valley, California, has been appointed manager of the Stockton, California, office.

F. E. Colien, with the Tri-State Telephone and Telegraph Company, at River Falls, Wisconsin, has taken a position in the commercial department of the Central District Telephone Company, in the Pittsburgh, Pennsylvania, district.

Charles Hall, president of the Coos & Curry Telephone Company, Marshfield, Oregon, is president of the Bank of Southwestern Oregon, which recently purchased and succeeded to the banking business of Flanagan & Bennett Bank, of Marshfield, Oregon.

NEWS FROM THE FIELD.

ARKANSAS.

McRae has a local telephone system. It is owned by T. H. Young, of Judsonia, who also owns the local systems at Judsonia and Kensett.

COLORADO.

The Mountain States Telephone and Telegraph Company is building a line of four No. 12 copper wires through Parleys canyon, in the direction of Evanston, Wyoming, to meet a line being constructed west from Denver. In the engineer's office it is stated that this new line between Salt Lake and Denver, is a part of this year's budget of improvements by the company, but that the government may take it over in forty days for war and other purposes. Otherwise the line will form a regular part of the intermountain system.

ILLINOIS.

At a meeting of the stockholders of the Farmers' Telephone Company, of Hopedale, E. S. Sterrett, of Henry, C. B. Cheadle, of Joliet, and W. A. Potts, of Pekin, were elected directors. Under the new organization Mr. Sterrett is president and general manager, and Mr. Cheadle is secretary and treasurer. The retiring officers were W. M. Mount, president and general manager, W. H. B. McCormick, secretary and treasurer.

With the announcement by the Central Union Telephone Company of the purchase of a $25,000 building site and of plans made for the erection of a new $100,000 building at Springfield, it is practically certain that the state offices of the company will be retained in Springfield despite efforts being made by Peoria to have the offices located there. The ground purchased belonged to Charles T. Appleyard and adjoins the present Fifth street building.

Comptroller Pike made public a report of the Chicago Tunnel Company showing a deficit of $50,000 in the operation of the automatic telephone. The city gets $4,700 as its share of the gross receipts of the system and $32,000 as its share of the operation of the tunnel—8 per cent of the gross.

Two blocks of cable will be laid this spring by the Buckley Telephone Company, city and other improvements are to be made. The cable will extend from the Fencken Building north to the exchange, and from the north street to the exchange. This will do away with much of the overhead wiring in the business district.

During the first three months last year the Chicago Telephone Company gained 13,000 telephones, while for the same period this year the gain is 15,000—12,200 in the city and 2,800 in the suburban division. The gain is in excess of 60,000 telephones a year, and is greater than ever before. There is a constantly increasing difficulty in adding new telephones because of the shortage of material of all kinds. The supply of everything that goes into the building of a telephone exchange is about exhausted and little can be had even at almost double the old prices.

The Chicago Telephone Company has leased for a term of four years two of the store buildings in the Moose Building in Island avenue and plans to get into the new quarters about May 1. The commercial department of the company, now located in the building in Stolp avenue, will be moved to the Moose Temple.

INDIANA.

Stockholders of the Citizens' Telephone Company appropriated $250,000 for improvements during the coming year at the annual meeting of the stockholders held at Kokomo. This is a minimum appropriation and expenditures up to $300,000 may be made if required. Directors were elected as follows at the meeting: William N. Turner, Austin Jay, J. W. Stickney, Frank Wampler, and C. A. Cora. The officers are: J. W. Stickney, president; Frank Wampler, vice-president, and A. D. Lewis, secretary-treasurer.

A transaction was closed whereby George S. Akers, of Win-

gate, became the owner of the Otterbein Telephone Company, which has formerly been the property of L. S. and L. W. Connarroe. The company will still operate under the articles of incorporation, Mr. Akers holding the same by members of his family assuming the role of stockholders and officers. L. W. Connarroe, who has since July 1, 1916, been in charge of the local plant, will move to Brookston on or about May 1 to take charge of the exchange which he and his brother own there.

IOWA.

The Midway Telephone Company is the name of a new farmers' organization at Mason City, articles of incorporation of which were filed with the county recorder. Its capital stock is $10,000 and its officers are: Ed Freeze, president; Peter Peterson, vice-president; M. G. Bell, secretary and treasurer. Other incorporators are W. G. Freeze, Eliza Senior, William Albertson and Thomas Casperson.

The telephone despatching service on the Erie between Marion and Dayton is now in good working order, and with the installation of the service, the Erie has telephone connections over the entire system with a few places to be cut in. H. A. Connors has been made telephone maintainer.

After a series of meetings the farmers of Sumner have come together and incorporated under the name of the Sumner Farmers' Mutual Telephone Company. Articles of incorporation were read and adopted, and over $3,000 worth of stock sold. The shares are to be sold for $50 each, with a limit of not more than five shares to any one person. The capital of the new corporation is fixed at $30,000 with 25 per cent paid-up stock before the business is started.

The Decatur County Mutual Telephone Company is running an underground cable through the property of Joseph Hamilton and the Harvey park in south Leon, which will carry all the lines across these properties underground. Eventually the company hopes to have all the wires inside of Leon underground, and do away with the poles on the streets and in the alleys.

KENTUCKY.

The Cumberland Telephone and Telegraph Company is making wonderful improvements in the system at Springfield. All overhead wires have been removed and replaced by cables and insulated wires which will eliminate troubles formerly experienced to a very great extent. The present system not only was rebuilt with an eye to efficiency and general appearance, but to take care of all increase in business for a number of years. The system now equals the high standard of efficiency demanded by the Bell system throughout the United States and the subscribers may look forward to prompt service. The total cost of the work done is about $7,000.

MASSACHUSETTS.

The telephone switchboard at the Boston navy yard is now operated by girls for the first time. They took the place of marines who were assigned to other duty.

MICHIGAN.

Detroit soon will be linked with a new, low-rate, long distance telephone circuit, which will embrace all the large cities of the country. The system now is being worked out in the west by the Postal Telegraph Company. C. F. Crittenden, manager of the Detroit office, says the St. Louis and Chicago circuit now being linked up eventually will be extended to Detroit. It is the purpose of the new service to furnish competition with the American Telephone & Telegraph Company.

MINNESOTA.

Changes at the Northwestern Telephone Company's St. Cloud office have been announced. W. H. Howland, who has been manager of the St. Cloud plant, goes to Wadena to succeed E. B. Carlson, who is placed in charge of the plant department. J. N. Endicott of Brainerd is to be manager of the St. Cloud office.

MISSISSIPPI.

M. H. Woodward of Louisville, who has charge of the telephones at Philadelphia, has recently moved the exchange office from over the Sanford Stable building to the Philadelphia Bank building. The change was made and completed in less than a day. It is reported that Mr. Woodward made a contract with the Bank of Philadelphia for the offices they now occupy for 100 years or as long as he is in the telephone business. A number of the open wires have been replaced by cable which will make the services more satisfactory.

The Cumberland Telephone and Telegraph Company at Meridian is extending its underground system to Sixteenth street on Twenty-fourth avenue. The work is under the general plan for improved telephone service in the city.

MONTANA.

Practically all the stock in a $10,000 telephone corporation has been subscribed by farmers of the Flatwillow bench country, and work on the line will begin at once. Besides supplying the rural district, the line will connect with the Round-up-Lewistown toll line and provide means of communication with the two county seats. About 75 telephones will be installed and the equipment will be standard throughout.

At a rousing meeting of farmers held at a school house near Westby an organization was formed whereby a telephone line is to be built from Westby to Grenora, the latter being a new town established across the North Dakota line, east of Dagmar. Switch boards will be established at Westby and Grenora, leaving the line between those two towns clear, and later farmer lines will be connected with these switch boards as desired. The directors of the company are Nels Nelson, John K. Borg, Otto Jensen, George Kittleson, and Attorney Peterson of Grenora. The stock will be $80 a share.

NEBRASKA.

The state railway commission has authorized the Nebraska Telephone Company to issue $1,000,000 more capital stock.

NEW YORK.

Several properties sold within the last few weeks on Thirtieth and Thirty-first streets, between Second and Third avenues, New York City, have been purchased by the New York Telephone Company for improvement in the near future with an office building and exchange. The property acquired includes fifteen old dwellings at 227 to 243 East Thirtieth street and 224 to 234 East Thirty-first street. The frontage is 180 feet on Thirtieth street by 112.6 on Thirty-first street. On the latter street the holdings adjoin the Church of the Incarnation, near Second avenue. The projected building is intended to relieve the burden of business of the Madison Square station.

Plans have been filed for a five-story fireproof telephone exchange and office building, at 206 to 224 West Thirty-sixth street, for the New York Telephone Company. It will have a frontage of 171 feet and a depth of 98.9 feet. McKenzie, Voorhees & Gmelin, the architects, have estimated the cost at $500,000.

NORTH DAKOTA.

The telephone company at Garrison will rebuild its lines in that town this coming summer. The work has already started.

Business men of Kildeer and Grassy Butte are backers of the newly organized Kildeer-Grassy Butte Telephone Company, which will maintain exchanges in the two cities, and also maintain an extensive rural service.

The Medford Mutual Telephone Company held its annual business meeting at the office of its president, Dan McKeith. The financial report showed good earnings for the year. The switchboard will be removed from the Pleasant-View farm to the residence of C. Holwerda, of DeWar.

A new telephone company, under the name of the Golden Circle Telephone Company, was organized in Stark county. The line will run from Belfield to Zenith and then south for a distance of about ten or twelve miles.

The Mandan Telephone Company Exchange has received a new $6,000 switchboard which is to be installed in the Nigey hotel building.

A telephone company, to be known as the North Line Telephone Company, will soon be doing business in the country north of Halliday. Thirty-nine farmers have subscribed and taken stock in the company and work will be started on construction as soon as the frost is out of the ground.

Using their own funds, the Commercial Club of Bowman will erect a trunk telephone line twenty miles straight south to the South Dakota line. The farmers of each township will organize a line unit of 15 telephones and string their wire into Bowman. At the South Dakota line Ludlow people with the efforts of Senator Glendenning will extend the line to Buffalo, South Dakota, so that altogether two hundred miles of line will be erected this summer.

OHIO.

The Central Union Telephone Company in Dayton has announced the purchase of a site at Delaware and Richmond avenues for the construction of a branch exchange for Dayton View. A fire-proof building is to be built as soon as possible. The property was purchased from D. W. Allaman.

The Williamsburg Telephone Company in Clermont county has been purchased by the Cincinnati and Suburban Bell Telephone Company subject to approval by the Utilities Commission. The value, after depreciation was eliminated, was given as $14,557.22. There will be an inventory filed and the case will not be heard before June 1. Less than 200 telephones are included in the sale.

After a week of war with the Bell Telephone Company at Niles the Warren avenue residents emerged from the battle victorious, the Bell people surrendering for the present at least, having moved their poles from the street.

The annual meeting of the stockholders of the LaRue Tele-

phone Company was held and the following directors were elected: Charles S. Stahl, of Kenton; W. S. Crater, of Columbus; C. H. Virden, of Meeker, and W. S. Kniffin, W. H. Johnson, L. G. Copeland and W. E. Denman, of LaRue. The directors will meet and organize some time in April.

The Mineral Springs telephone exchange will soon be a thing of the past. It will be moved to Wamsley and be combined with the Blue Creek exchange which will be known after this as the Wamsley exchange.

OREGON.

The annual report of the Mt. Angel Telephone Company, filed with the public service commission, shows the operating revenues as $918.10 and the operating expense $779.66. The company states that its actual cost of the plant is $4,992.34, and it serves 107 patrons. No dividends declared. Operating revenue of the Yamhill Electric Company of Newberg is given as $37,011; operating expense $23,870, leaving a net revenue of $13,140.

The Valley View Telephone Company at Ashland has finished connecting its system from the Wreath ranch to Eagle Point, north of town. About seven miles of wire have been strung, the improvement costing $400. It is known as No. 18, with eight subscribers to date, with more to follow.

PENNSYLVANIA.

The Bell Telephone Company is preparing for the expenditure of more than $400,000 for a new central office to be known as "Manheim," adjoining the company's present Germantown central office, 26 to 34 West Chelten avenue. The building, it is estimated, will cost about $235,000, while the telephone equipment, new, as well as that now in use, which must be rearranged, will cost about $162,000, in addition to which about $10,000 will be spent for new outside plant equipment. For the present the structure will be three stories, with a basement, but provisions will be made for two more stories as they may be needed. It is expected that the Manheim exchange will be completed by midsummer of 1918.

The Bell Telephone Company has taken title from Edward W. Johnson to the three dwellings on the south side of Lancaster avenue, adjoining its local exchange building at the southeast corner of Lancaster avenue and Media street, west of Fifty-first street, Philadelphia. The dwellings occupy a lot 66 feet on Lancaster avenue with a depth of 135 feet and are assessed at a total of $14,900. The lot occupied by them will be used to enlarge the exchange station.

TENNESSEE

The Murfreesboro Home Telephone Company and the six other Home Telephone exchanges operating in that section have been merged and are to hereafter be controlled by one board of directors. The following officers have been elected by the board: A. L. Carnahan, president; W. F. Dickens, treasurer; Lester W. Dann, secretary.

A crew of telephone linemen and expert electricians have arrived at Gallatin and work toward the installation of the flash-light system for the Cumberland Telephone Company has begun. The handsome new building of West Main street, which will be occupied by that company, is nearing completion and preparations for considerable amount of new cable in various parts of town have been made.

At a largely attended mass meeting held at Manchester the Manchester Home Telephone Company was organized. Thirty telephones were assured, and it is believed that many more will be secured. Nine directors were elected: Adam Simmons, J. J. Finley, John H. Leming, J. H. Ashley, J. P. Williams, G. R. Morton, J. B. McMahon, J. C. Crocker and J. P. Buchanan. The directors met and elected the following officers: President, J. C. Crocker; vice-president, J. P. Buchanan; secretary, J. B. McMahon; treasurer, John H. Leming.

The erection of a new branch exchange building at the corner of Colonial avenue and Twenty-seventh street, Norfolk, to take care of the rapidly growing telephone business is planned by the Chesapeake and Potomac Telephone Company. Immense electric cables, the largest made, are now being placed in the company's conduits beneath the streets and will eventually be used to serve the new exchange. It will be equipped with a 10,000-line switchboard.

VIRGINIA

Due to the enormous increase of the business of the Chesapeake and Potomac Telephone Company it has been found necessary to renew and rebuild much of the old system. Practically all the trunk lines west of Roanoke have been rebuilt, and in many places it has been found necessary to renew transmission plants. At Vinton a new plant has just been put into use, and additional facilities are under construction at Pulaski.

Fourteen men have arrived at Petersburg to begin the putting up of two additional copper wires for the American Telephone and Telegraph Company between Petersburg and Norfolk. The additional wires are said to be required by the increased business on these lines.

WISCONSIN

A meeting of the plant employes of Eau Claire and Chippewa Falls exchanges was held in the assembly room at the local exchange building of the Wisconsin Telephone Company. A complete review of the plant accounting and construction methods was taken up and discussed and some instruction given on work laid out for this year. In addition to all plant employes of the Eau Claire and Chippewa exchanges the following were in attendance: L. Killan, plant superintendent, Milwaukee; J. P. Brennon, superintendent of lines and equipment, Milwaukee; W. E. Schroeder, division inspector, Milwaukee; P. J. Skolsky, district manager, Eau Claire; L. Zarbock, district foreman, Eau Claire; J. V. Young, district wire chief, Eau Claire; F. Schoenhofen, manager, Chippewa Falls; J. E. Bonell, manager, Eau Claire.

The Baraboo Farmers' Telephone Company held its annual meeting at the courthouse. L. H. Palmer, W. A. Schreiber and S. P. Searle were elected as directors for three years and Grant Hackett for one year, to fill the unexpired term left vacant by the death of George Henry. Officers for the following year were elected as follows: L. H. Palmer, president; W. A. Schreiber, vice-president; H. C. Langdon, secretary and treasurer; W. L. Halsted, manager. It was decided to raise the rates from nine to ten dollars per year and a set of rules was adopted.

Directors of the Wisconsin Telephone Company elected these officers: President, Bernard E. Sunny; vice-president and treasurer, Alonzo Burt; vice-president, H. F. Hill; general manager, H. O. Seymour; general counsel, Eugene S. Wilson; general auditor, B. S. Garvey; secretary, W. I. Mizner. Expenditures amounting to $208,965, covering new construction and repairs to the local plant at Milwaukee, were approved, and expenditures amounting to $307,135, covering new construction and repairs to the plant outside of Milwaukee, were approved. The quarterly dividend of $2 a share was declared.

Directors for the coming year were elected at a meeting of the Oneida Farmers' Telephone Company held in the office of C. P. Crosby. The directors follow: C. P. Crosby, T. C. Wood, C. J. Jensen of Heafford Junction, Ira Smith, and A. K. Tresness, both of Cassian. It was decided by the organization to sell $4,000 worth of outstanding stock.

INCORPORATIONS

Cortland Home Telephone Company, Cortland, Jackson county, Indiana; capital, $300; telephone lines and exchanges; directors, D. B. Manion, Holmes Robertson, Curtis Robertson.

Mussel Shoals and Cattle Bend Telephone Company of Frankfort, Kentucky; Isaac Rowland; capital, $285; incorporators, Lee Peyton, Joe Carpenter, J. W. Hasty, R. C. May.

Wintersville Telephone Company, Wintersville, Ohio; $1,500; Joseph M. Carroll.

Big Brook Rural Telephone Company; $500; Oneida county, New York; William F. Miller, Robert O. Roberts, Frank E. Vandresar.

Present-Day Radio Apparatus

Given a small, low aerial, it is not uncommon for the average American radio amateur to receive messages over a radius of several thousand miles from government and commercial stations. And, what is more, the amateurs can hear each other at distances well over a thousand miles in many instances, even if their transmitters are usually of one kilowatt or less. Amateurs in New York city have no difficulty in reading the signals of amateurs in the Mississippi Valley; in fact, amateur stations as far west as Dallas, Tex., are often heard. As to what can be done without an aerial, a correspondent of the *Wireless Age* states that he has recently designed and built a receiving instrument with which, by using only one vacuum valve, he is able to read stations at a distance of 600 miles or more, without any antenna whatsoever. In fact, he states, there is nothing connected to the aerial binding post of his apparatus, nor is there an aerial within a mile of his residence. All he uses for the ground connection is a wire connected to a small piece of iron stuck in the earth.